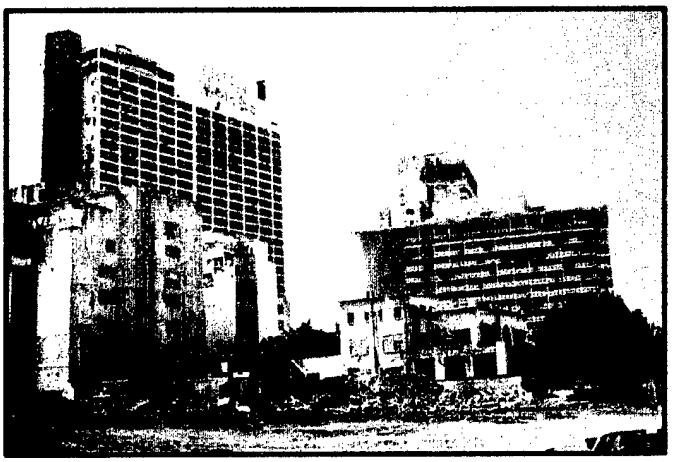
Urban Warfare Mobility Analysis



Final Report

Prepared for

Naval Surface Warfare Center

Carderock Division

by

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This FINAL report presents the results of a study to assess the implications of conducting military operations in an urban area from the standpoint of the individual, and particularly from the standpoint of ground vehicles and to propose two urban vignettes thatcould conceiveably occur within the standard available Marine Corps scenarios.

The study team examined emerging operational concepts, current doctrine, mission needs statements, current capabilities, survivability and lethality data, Government provided scenarios, and, a variety of lessons learned from diverse sources. The recommended improvements to urban mobility consist of : 1) Improved countermine and obstacle clearing capability; 2) Improved survivability (to degrade effects of chemical and kinetic threats, and enhance self-protection capability); 3) Improved availability to furnish close combat service support (sustainment and casualty evacuation); and, 4) Improved agility (turning radius, ground clearance, acceleration).

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EXECUTIVE SUMMARY

This final report presents the results of a Booz·Allen & Hamilton study to assess the implications of conducting military operations in an urban environment from the standpoint of the individual, and particularly from the standpoint of ground vehicles, and to propose two urban vignettes that could conceivably occur within the standard available USMC scenarios.

The study team examined emerging operational concepts, current doctrine, mission needs statements, current capabilities, survivability and lethality data, and government provided scenarios and a variety of lessons learned from diverse sources. Based on the above, the study team investigated the requirements for improving the mobility capabilities of ground vehicles. The recommended improvements to urban mobility consist of:

- Improved countermine and obstacle clearing capability
- Improved survivability (to degrade effects of chemical and kinetic threats, and enhance self-protection capability)
- Improved ability to furnish close combat service support (sustainment and casualty evacuation)
- Improved agility (turning radius, ground clearance, acceleration)

The urban battlespace demands credible countermobility capability. The ground combat element of the MAGTF must be able to maintain the momentum of the offensive in urban operations, and road bound vehicles are susceptible to obstacles and mines. Threat systems have increased lethality against stationary targets, or vehicles slowed by mines or the threat of mines.

The urban battlespace is resource intensive. Typically it has generated the need for increased ammunition, supplies, and the concomitant requirement to evacuate casualties. The inability of a force to resupply or evacuate casualties degrades the mobility of the entire force. Improving the capability of the existing fleet to accommodate field expedient resupply or casualty evacuation operations is significant for urban and conventional operations. Any new vehicle should have the flexibility to be configured to perform both tasks.

The vertical dimension of the battlespace increases vulnerability to threats from above, on and below the horizontal plane, or street surface. In an environment of close engagement ranges, the amount of "dead space" in which a vehicle mounted weapon can not engage increases the vulnerability of the vehicle. Therefore, enhancements that minimize dead space have definite combat utility. Likewise, most lightly armored vehicles are least protected on their top surfaces, making them vulnerable to threats above the second story in urban environments. Therefore, improvements that reduce the lethality of threat systems from above the surface of the battlespace increase system survivability.

Vehicle employment in the urban environment must benefit from the insight provided by timely intelligence preparation of the battlefield. This doctrinal process requires commanders to include information about the width and direction of mobility corridors into their plan. This precaution should minimize the occurrence of vehicles being unable to travel or turn within roads suddenly too narrow, or steep. Within the realm of automotive engineering, vehicles that have a tighter turning radius (wall to wall), higher ground clearance, and the ability to rapidly accelerate in forward and reverse will perform more effectively than those that are less agile. Improvements of this nature enhance urban and non-urban performance, although the importance of improving these features may be more significant in urban operations. However, the underlying premise remains that dismounted infantry will continue to be the base unit for movement in urban operations, and that only in the most rare circumstance will vehicular forces be autonomously employed without the benefit of infantry protection.

TABLE OF CONTENTS

FINAL REPORT

1.0 INTRODUCTION

This final report presents the results of study to assess the implications of conducting military operations in an urban area from the standpoint of the individual, and particularly from the standpoint of ground vehicles and to propose two urban vignettes that could conceivably occur within the standard available USMC scenarios.

2.0 SCOPE

The scope is to determine potential mobility enhancements for ground vehicles, either fielded or systems under development, for the U.S. Marine Corps. The task focused on two major areas:

- Determine the requirements for improved mobility features for ground vehicles, based upon clear understanding of Marine Corps concepts and doctrine.
- Examine lessons learned from prior instances of urban warfare.

Provide recommendations for improving vehicle mobility characteristics for employment in the urban environment.

This report is unclassified. The classified vignettes are included in a separate appendix.

3.0 BACKGROUND

The Commandant's Planning Guidance, issued in 1995, discussed tactical mobility. It stated, "One of the keys to achieving decisive action is mobility. Without the ability to move rapidly, forces cannot concentrate to fight and then disperse. To preserve the advantage which speed provides, we must continue to improve our tactical mobility. From the combat load of the individual Marine to major weapons systems, improved battlefield mobility will be a paramount concern. This requires the acquisition of not only lightweight weapons systems, but also of advanced technology mobility assets in quantities sufficient to ensure a mobility advantage on the future battlefield -- with requirements always firmly anchored in our operational concepts."[1] Exploring solutions to tactical mobility within the urban environment emerged as a focus area for experimentation undertaken by the Marine Corps Warfighting Laboratory (MCWL).

The MCWL is preparing for the Urban Warrior Advanced Warfighting Experiment (UW AWE), to be conducted during March 1999. Urban environment threats exist on the subterranean, surface, and super-surface levels. Not all threats for this environment are well understood. This environment presents new and different challenges for tactical mobility and the conduct of maneuver warfare. By grasping the essential lessons learned by past military forces, the Marine Corps can pursue tactics, techniques and procedures, as well as employ new technologies, to fight and win in the urban battlespace.

Understanding which system capabilities contribute to improving tactical mobility in the urban environment is essential to the proper application of resources to requirements.

5

Scrutinizing concepts and doctrine will ensure that development efforts are channeled toward satisfying bona fide operational requirements.

4.0 METHODOLOGY

The methodology of this study is to explore the conceptual and doctrinal foundation for urban combat capabilities, and to derive the implications for improvements to our current capabilities. It requires addressing eight basic issues:

1. Review the concept and doctrine applicable to military operations in urbanized terrain (MOUT) – "What is the warfighting rationale for how the Marine Corps intends to fight?"
2. Define the urban environment – "What are the conditions under which we will fight?"
3. Define the urban threat – "What are the threats in the urban environment. Are some threats more significant than others in this environment?
4. Define the requirements to conduct MOUT – "What are the requirements that we need to satisfy to fight according to our concept and doctrine?"
5. Define the requirements for selected ground vehicles – "What are the current capabilities of these selected ground vehicles?"
6. Are there deficiencies in these ground vehicles – "Can we fight the threat, according to our concept and doctrine, in the urban environment, with our ground vehicles? Are there capabilities that these ground vehicles lack?"
7. Apply lessons learned to doctrine and requirements – "Does prior experience during other conflicts suggest the need for certain capabilities?"
8. Develop vignettes to explore capability drivers – "Use plausible scenarios that portray performance in the urban environment."

5.0 ASSUMPTIONS

- The study assumes conditions as anticipated for 2004-2007, particularly for threat systems availability.
- U.S. will continue to abide by existing treaty obligations, and will honor commitments to minimize collateral damage to non-combatants and their environment.
- Ground force equipment includes the Light Strike Vehicle (LSV), the Light Tactical Vehicle Replacement (LTVR) and the Light Armored Vehicle (LAV)

6.0 CONSTRAINTS

- Lack of data concerning specific trends of global urbanization, to include the use of road materials, road widths, building materials, and comprehensive information about trends in urbanization.
- The Advanced Amphibious Assault Vehicle (AAAV) is not yet introduced into the Marine Corps inventory. The AAAV may possess countermobility and mobility capabilities that affect the mobility of the force in the urban environment. However,

these capabilities are as yet indeterminable, therefore the baseline performance of the wheeled systems was based on the capabilities of the current AAV.

7.0 ANALYSIS

This section provides a description of the work accomplished and its relationship to the methodology described in paragraph 4.0. The paragraphs below describe the rationale for applying maneuver warfare in an urban environment and the requirements generated by this rationale for fighting in the urban environment. The lessons learned from prior relevant urban combat experiences are compared against the envisioned requirements for urban mobility, and an assessment is made about the mobility characteristics of vehicles for MOUT.

7.1 Review of Concepts and Doctrine.

7.1.1 Concept of Future MOUT. The Marine Corps' warfighting philosophy of maneuver warfare expands the understanding of maneuver from only the spatial dimension, to include the temporal dimension. It is described as a "warfighting philosophy that seeks to shatter the enemy's cohesion through a variety of rapid, focused, and unexpected actions, which create a turbulent, and rapidly deteriorating situation with which the enemy cannot cope.[2] Instead of beating down the enemy's defenses, maneuver warfare seeks to bypass these defenses in order to penetrate the enemy system and rupture it.[3] Maneuver warfare, in essence, seeks to apply strength against weakness. It depends on speed and surprise, and aims to shatter the enemy's cohesion, organization, command, and psychological balance.[4] Without speed and surprise, it is not feasible to concentrate strength against weakness.

Historically, siege and attrition have characterized warfare in the urban environment. In order to discover an approach to apply maneuver warfare, the Marine Corps has developed a *Concept for Future MOUT*. Designed for experimentation and research, the concept seeks to find ways to use maneuver warfare in urban combat. In order to bring this concept to fruition, a series of innovations and improvements are required. Technology and tactics leading up to the experimentation for the current UW AWE are addressing these enhancements. These enhancements are grouped into seven capability areas. These capability areas are:

- Command and Control
- Mobility/countermobility
- Measured firepower
- Survivability
- Adaptability
- Awareness
- Sustainability

These capabilities are complementary, and tend to reinforce each other. An examination of capability drivers in future urban warfare suggests that mobility enhancement devices might assist Marines in negotiating the complex, three-dimensional terrain found in a

modern city. For ground vehicles, the capabilities that directly apply are mobility/countermobility and survivability.

7.1.1.1 Mobility/Countermobility. Recognizing that speed and surprise are fundamental to maneuver warfare, the *Concept for Future MOUT* calls for creating "multi-spectral mobility." Multi-spectral mobility is the capability to move combat power rapidly through the three-dimensional urban battlespace. The focus for improving surface mobility is on providing a capability to create new lines of communication through intact or partially intact structures, in addition to conventional methods of negotiating roads and reducing obstacles. Additional enhancements to sub-surface and super-surface movement are prescribed. These capabilities should enable gaining surprise and speed in a dimension of the battlespace not heretofore exploited enable inter-dimensional movement of the individual Marine. The requirements for improvements in mobility are described as:[5]

- Rapid breaching of steel-reinforced concrete walls
- Vertical movement inside structures without the use of existing stair-cases
- Vertical movement on the outside of structures
- Horizontal movement between structures above ground level
- Penetration of pavement and building foundations for movement between surface and sub-surface zones

7.1.1.2 Survivability. Units maneuvering through streets against a prepared adversary historically have sustained high casualties.[6] Individual and collective capabilities are described to protect the force. One of these measures prescribes modifications to existing vehicles, or perhaps new vehicles, with additional armor protection on the top, multiple exits for embarked Marines, and improved capability to dispense multi-spectral obscurants. (multi-spectral, in this case, refers to the electromagnetic spectrum, vice the "multi-dimensional" notion described for mobility.)

7.1.1.3 Summary. The *Concept for Future MOUT* seeks to improve conventional mobility capabilities by forcing our adversaries to oppose our advances on the surface, below the surface, and above the surface. The viability of the Marine Air-Ground Task Force (MAGTF) remains intact, and much of the above-surface capabilities are tied to improved aviation capabilities. The survivability of most vehicles could be improved by use of a kit to improve their organic top surface protection. Ground vehicles could assist the mobility of the individual Marine in the multi-spectral battlespace by supporting the capability to:

- Penetrate buildings in order to create other man size holes at ground level
- Possess a detachable "hook and ladder" extendable device enabling Marines to access roofs and second and third stories of urban structures.
- Possess inset areas on vehicle/trailer chassis that accommodate the placement of ladders and extendable devices to enable Marines to access upper stories of buildings

These mobility and survivability enhancements do not require a new vehicle. They might be contained in a kit that is fitted to a vehicle, or in a trailer that is towed, and provides an urban peculiar capability. The *Concept for Future MOUT* does not describe a broad improvement to ground vehicle mobility.

7.1.2 Doctrine. Marine Corps Doctrinal Publication 3, *Expeditionary Operations*, was approved by the Commandant of the Marine Corps on 16 April 1998.[7] This doctrine recognizes:

- Increasing military significance of urbanized terrain
- Growth of shantytowns as an extension of urban areas
- Urban terrain favors defender
- Greater use of ground forces, especially infantry
- Use of mechanized/motorized forces is restricted

Marine Corps Warfighting Publication 3-35.3, *Military Operations on Urbanized Terrain*, was approved by the Commandant of the Marine Corps in April 1998. This document supersedes Operational Handbook (OH) 8-7, *Military Operations on Urbanized Terrain*, dated November 1980. MCWP 3-35.3 focuses on the ground combat element of the MAGTF and how it integrates the support of the elements of the MAGTF for combat in the urban environment. This publication accepts the basic principles of urban combat that have remained unchanged essentially since the Second World War. The doctrine reiterates the principles found in MCDP-3, and adds several key insights. Among these insights are:[8]

- Maneuver warfare doctrine must be applied to the environment
- MOUT is infantry intensive
- Armor, artillery, and aviation are effective at the outer perimeter of built-up areas for causing isolation or preventing reinforcement
- Armor operating inside a built-up area must be protected by infantry
- Artillery providing direct fire inside a built-up area can be effective in the reduction of strongpoints
- Attack of an urban area is costly to the attacker in terms of resources and casualties
- Urban warfare is time consuming
- Isolation of an urban defender ultimately ensures his defeat

This doctrine provides a tactical approach to conducting MOUT that is executable by current Marine Corps force structure and equipment. Exploiting "multi-spectral mobility" is not emphasized in this doctrine because the capabilities required for multi-spectral mobility are not available within the force. The speed and mobility of dismounted infantry will be the governing factor on the speed of ground vehicles in urban operations.

7.2 The Urban Environment. The Marine Corps mission as an expeditionary force in readiness requires the capability to operate effectively on the littorals, which are increasingly dominated by expansive urban areas. The Marine Corps recognizes the complex nature of urban warfare, and describes the problems posed by the urban

environment in the capstone doctrinal publication MCDP-3, *Expeditionary Operations*, as outlined earlier.

7.2.1 Urbanization. In general, urbanization is normally expressed as a function of population density. Different nations define urbanization differently. What might be considered "urban" in a country like Finland, might not be considered urban in India. Therefore, there is no uniform definition of what level of population density constitutes an urban area. However, a 1996 UN report found that the urban population is increasing much faster in developing countries than in the more-developed regions and provided the following summary of urban expansion.[9]

In 1970, there were about as many city dwellers in developing countries as in the more-developed regions. The ratio is nearly two to one today; it will pass three to one by 2015 and approach four to one by 2025. Of the 1.23 billion urban residents added to the world population since 1970, 84 per cent have been in less-developed regions, and this proportion is growing. In general, population growth occurs in one of two ways. First, growth occurs within the existing or planned municipal limits, increasing population density. This is the case within Seoul and Shanghai.[10] Second, unplanned growth occurs at the fringe of the city, frequently in squatter settlements, or shantytowns that lack basic city services. The current percentage of urbanized population is depicted in Figure 7.2.1 It is projected that less-developed regions will account for 92.9 per cent of a more than 2 billion increase in the global urban population between 1995 and 2020. In terms of total population numbers, Asia now accounts for 1.2 billion of the 2.5 billion global urban residents, i.e. about 46 per cent. Europe accounts for 535 million more. By 2025, 23 new urban Asians will be added for every new European urban resident. Latin America and the Caribbean account for about 358 million current urban residents. In 2025, these numbers will be: Asia, 2.7 billion; Europe, 598 million; Latin America and the Caribbean, 601 million; and Africa, 804 million. The table below depicts the percentage of the regional populations that are occupied by urban-dwellers, according to a 1996 UN study.[11]

Levels of Urbanization

Africa		Asia		Caribbean & Latin America	
South Africa	48%	South Central Asia	28.8%	Caribbean	62.4%
North Africa	45	East Asia	36.9	Central America	68
West Africa	36	Southeast Asia	33.7	South America	78
Middle Africa	33				
Eastern Africa	21				

Table 7.2.1

By the year 2000, 20 of the 30 largest cities in the world will be in developing countries. The total population living in urban areas of developing countries is expected to grow from 275 million in 1950 to 1.9 billion by the year 2000.

7.2.2 Global Urban Characteristics. The growth of urban developments, and the accompanying increase in population, occurs without regard to existing norms and standards. There are several prominent global trends in urban development, all which complicate the conduct of urban operations, and which generally tend to favor the defender.

- High rise apartments
- Reinforced concrete construction
- Shopping centers
- Truck-related industrial storage areas
- Suburban growth

Urban areas can be categorized by population and construction density, road patterns, presence and complexity of utilities, road networks, and neighborhood patterns. There are trends that reflect economic and cultural bases of the various geographical regions. Colonization gave most major cities throughout the world certain European characteristics. They have combination street patterns, distinct economic and ethnic sections, and areas known as shantytowns. All of which present obstacles to vehicles. A summary of regional urban characteristics, provided from FM 90-10-1, *An Infantryman's Guide to Combat in Built-Up Areas,*[12] follows:

Middle East and North Africa
- Nations accessible by sea
- Urbanization rates are high
- Severe summer climate makes life outside cities difficult
- Ancient cities have expanded into their current metropolises
- Petroleum economies have spawned new cities
- European influence and petroleum revenues have resulted in urban centers with modern sections of multistory buildings

Latin America
- Most urban centers accessible by sea
- Many capitals serving as ports
- Spanish influence characterized by broad avenues that radiate outward from a central plaza with a large church and town hall
- Upper and middle class sections combine with the urban centers
- Lower class sections are located farther out
- Poor sections are located in slums at the outer edges of the city

Far East
- Except for Mongolia, all nations in this region can be reached by sea
- Urbanization is dense, especially in coastal cities where modern commercial centers are enveloped by industrial developments and residential districts

South Asia
- Significant European influence with wide, overcrowded busy streets
- Urban centers may have poorer native sections with few or no public services and alleys no more than a yard wide

Southeast Asia
- Significant European influences with all capitals and major cities serving as seaports
- Urban centers contain both the older, high-density native quarters with temples or religious shrines, and modern sections with boulevards, parks, and warehouses

Sub-Saharan Africa
- This region is not accessible by sea and has hostile terrain
- With few exceptions, most large cities did not exist prior the arrival of the Europeans
- Most cities are relatively modern and without an "old quarter," and most have shantytowns

Characteristics of Urban Environments. Military geographers divide a typical urban area into the following parts: city core, commercial ribbon, core periphery, residential sprawl, outlying industrial areas, and outlying high-rise areas. This method of classification enables sound application of the intelligence preparation of the battlefield process, detailed in FM 34-130, *Intelligence Preparation of the Battlefield*, by military planners prior to the conduct of MOUT. Understanding the urban topography, and specifically, the limits imposed on mobility by road width, curb heights and road surfaces, is essential to the employment of the force, to include the use of ground vehicles. These characteristics in developed and developing countries differ more in degree and style rather than in structure and function.

City Core. In many cities, the core has experienced more recent development than the core periphery. Consequently, the two regions are frequently quite different. Typical city cores of today are made up of high-rise buildings, which may vary greatly in height. Modern planning for built-up areas allows for more open spaces between buildings than in old city cores or in core peripheries. Outlying high-rise areas are dominated by this open construction style more than city cores.

Commercial Ribbon. Commercial ribbons are rows of stores, shops, and gas stations, and eateries that are built along both sides of major thoroughfares through urban areas. Usually, such streets are 25 meters wide or more. The buildings are uniformly two to three stories tall—about one story taller than the dwellings on the streets behind them.

Core Periphery. The core periphery consists of streets 12 to 20 meters wide with continuous fronts of brick or concrete buildings. The building heights are fairly uniform—2 or 3 stories in small towns, 5 to 10 stories in large cities.

Residential Sprawl. Residential sprawl and outlying industrial areas consist of low buildings that are 1 to 3 stories tall. Buildings are detached and arranged in irregular patterns along the streets with many open areas. Residential sprawl accounts for much of

the rapid and irregular growth in cities. Slums and shantytowns constitute most of the residential sprawl in the developing world. Frequently this growth is not reflected on maps or official records, yet represents much of the growth of the urban world. These areas are characterized by:

- High density population
- Insignificant infrastructure
- Abundance of temporary structures
- Thoroughfares tend to be alleys, frequently less than one meter wide
- Roads are not graded and are unpaved
- Areas are not represented on maps or graphics

The maze-like layout of these areas makes local knowledge indispensable, and can severely penalize the intruder. Shantytowns provide ideal terrain on which to establish an urban ambush killing zone. The location of shantytowns on the periphery of large urban areas can constrict the surface movement of friendly forces towards a military objective deeper toward the city core, and or provide an urban adversary an environment in which to "melt into." Either case exacerbates the difficulties of minimizing unnecessary collateral damage, and protecting friendly forces. As recently as 1996, the World Bank reported the following statistics regarding the demographic trends of shantytown expansion:

- In India's main cities of Bombay, Calcutta and Delhi, between 40 and 50 percent of the residents live in congested, haphazard settlements and unhealthy slums lacking city facilities, such as water, sewerage or garbage collection
- In Nairobi, Kenya, squatter settlements make up 55 percent of the total population
- About 70 percent of households in Lilongwe, Malawi are squatters
- About 55 percent of the population in Caracas, Venezuela are squatters
- About 50 percent of the population in Dar Es Salaam, Tanzania are squatters
- About 45 percent of the population in Karachi, Pakistan are squatters [13]

As recent as August 1998, during fighting in Kinshasa, the shantytowns became key military terrain. The *Washington Post* reported:

> Some of the sharpest clashes have taken place in the heavily populated eastern edge of the city near Ndjili International Airport -- a district called China by residents because of its congested streets. Congolese officials said government troops were trying to clear civilians from rebel-held pockets there, apparently to make it easier to attack rebel concentrations.[14]

One author notes that urbanization, and the uncontrolled growth of urban slums may contribute to the growth of insurgency, terrorism and other forms of political violence and instability. The causal relationship is complex. A number of factors are likely to contribute to greater violence in urban areas. These include periodic economic crises, the inability of regimes to cope with the political and social mobilization generated by urbanization, and grassroots demand for democratization. An underclass of young men

having few marketable skills, could form a pool of potential "warriors," that is, post-modern "anti-soldiers" eager for camaraderie and conflict.[15]
Furthermore, none of the aforementioned statistics is recent enough to incorporate the effects of global economic destabilization, which started in Southeast Asia in the summer of 1997. The collapse of many emerging market economies aggravates the dire circumstances of many urban dwellers. When commodity-based economies weaken, people leave the land for the city, in search of employment or sustenance. The published projections about urban population growth in the third world may under-represent the rate of growth. In the last ten years urban settings have provided the environment for most urgent requirements for US military intervention. Major operations have been conducted in Panama City, Port-au-Prince, and Mogadishu, and ostensibly non-combatant evacuation operations have been conducted in Tirana, Kinshasa, Monrovia, Freetown and Mogadishu. None of these cities lies in the developed world, and the likelihood for future operations in third-world urban environments remains high.

7.2.3 Military Significance of Urbanized Terrain. Urban terrain is considerably more complex and demanding than natural environments. It nullifies the customary advantages that modern armed forces have enjoyed on the open battlefield. There are significant military aspects of operating on urbanized terrain. These include:

- Reduced acquisition distance and engagement ranges - targets are usually exposed for a short period of time at ranges of 100 meters or less
- Danger from ricochet and fragmentation are increased due to increased vertical surfaces within battlespace
- Width of streets limits vehicular mobility
- Infringement on use of line-of-sight communications
- Increased use of ammunition and supplies

7.2.4 Subterranean Urban Areas. Subways and sewer systems dominate the mobility aspect of the subterranean environment for most urban areas. Cellars and basements are also part of the subterranean battlespace, and provide the defender with another area to use fight from. Whereas most urban areas will have underground sewer lines, not every urban area is developed enough to have a subway system. A survey of current literature reveals the following number of subways, either existing or under construction:

Distribution of Subway Systems

Geographic Region	Less than 50 miles from coast	More than 50 miles from coast	Total
Europe	22	16	38
Asia	22	20	42
N. America (U.S. & Canada)	10	11	21
S. America	6	4	10
Africa	0	1	1
Australia	1	0	1
Total	61	52	113

Table 7.2.4

Subways are transportation features of more developed economies. The majority of these systems are in North America, Europe and Asia. Those in Europe and Asia are located in western Europe and in Japan and China, respectively. These networks might present a limited opportunity to use ground vehicles modified for underground employment. However, the incidence of these underground networks is less prevalent in the littoral regions that Marine Corps has operational interest in.

7.3 Requirements for MOUT. The Marine Corps combat development process uses a concept based requirements methodology to guide research, development and acquisition of materiel solutions for operational needs. Simply put, there must be a clearly articulated need for a capability before a material solution is pursued. The search for improved capabilities to enable U.S. forces to operate more effectively within the urban environment has generated a multi-tiered effort within the Department of Defense. This effort began in earnest with the 1994 Defense Science Board report on MOUT. Under the aegis of the Joint Warfighter Science and Technology Plan, a series of technology objectives have emerged that support the development of improved capabilities for MOUT. For the Marine Corps, most of these requirements are manifest in the companion efforts of the OSD's MOUT Advanced Concept Technology Demonstration, or MOUT ACTD, and the Marine Corps Urban Warrior AWE.

7.3.1 Joint Warfighter Science & Technology Plan. The Director, Defense Research & Engineering has published the Joint Warfighter Science & Technology Plan. Chapter IV is devoted to Military Operations on Urbanized Terrain. In that chapter, a group of operational capability elements (OCEs) are described. These OCEs need to be satisfied in order to enable U.S. forces to employ Joint Vision 2010 in the urban environment. The primary emphasis of these OCEs is to improve command and control, and intelligence capabilities of U.S. forces. Improving these two capabilities leverages companion improvements in strike, protection, and maneuver. The OCE of maneuverability is described in terms of "the ability to apply the multidimensional aspects of information superiority and the ability to insert forces where and when we want them to accomplish

assigned tasks within the constraints of the urban environment. Situational awareness is one critical enabling ingredient."[16] However, there is no OCE pertaining to improving the mobility for ground vehicle systems.

Attaining the objectives delineated in each of the MOUT Defense Technology Objectives (DTOs) requires the integration of capabilities within a given operational area. These DTOs are, in effect, waypoints on the path to achieving a full spectrum of enhanced operational capability elements in MOUT. Each DTO represents a complement of interim capabilities within that specific area. The MOUT ACTD intends to complete the integration, interoperability, and linkage across many of these operational areas to achieve the full-spectrum, seamless MOUT capability. The successful implementation of this technology plan will result in substantial improvements in the ability of U.S. forces to effectively and efficiently accomplish missions, including general war, contingency operations, counterinsurgency, and peace and humanitarian operations in built-up areas.

The requirements of the MOUT ACTD were derived from the 1994 Defense Science Board study that prescribed needed improvements in thirty-two operational requirements. These requirements were divided into four categories; (1) Command, Control, Communications, Computers and Intelligence (C4I), (2) Engagement, (3) Force Protection, (4) Mobility, and (5) Modeling and Simulation. The sole mobility requirement is defined as "R28: Get on top of building: Need the ability for the average soldier/Marine to quickly get on top of buildings - both from the ground and from adjacent buildings." There are no requirements to improve the capability or add a new capability for ground vehicle systems.

7.3.2 USMC Mission Needs Statement for Improved MOUT Capabilities. The Marine Corps has refined the broad capabilities outlined in the Concept for Future MOUT, and has approved a Mission Needs Statement (MNS) for An Improved Capability to Conduct Military Operations on Urbanized Terrain (INS 1.27). These needs are categorized according to the developmental approach and the functional capability. Potential material alternatives are described as (1) Product Improvement Program, (2) Nondevelopmental Approach, or (3) Research & Development.

The breakdown of the requirements, detailed in the MNS is as follows[17]:

Product Improvement Program	
Requirement	
Force Protection Enhancements	Added protection to the vulnerable top armor of armored vehicles against the threat of engagement from elevated positions
	Protection for vehicles, crew, and passengers from thrown objects

Non-developmental Approach	
Requirement	
Mobility Enhancements	Family of building entrance tools that enable swift, silent access through doors and windows
	Selectively and quickly isolate or block critical avenues of approach ranging from doorways to city streets (countermobility)
	Rapidly breach steel-reinforced concrete walls
	Penetrate pavement and building foundations for movement between surface and sub-surface zones
Command and Control Enhancements	The capability for ground troops to communicate with combat vehicle crewmen without the use of a dedicated radio and without unduly exposing personnel to enemy fire
Force Protection Enhancements	Have visible and IR markings, which can be hand emplaced or remotely delivered to mark doors, windows, walls, vehicles, and personnel
Research and Development	
Requirement	
Mobility Enhancements	Means of getting to the top floor of a building from either ground level or an adjacent building without use of helicopters or grappling hooks
	Method of detecting and marking conventional or chemical mines, conventional, chemical or biological improvised exploding devices, and booby traps in and around buildings and means to quickly mark lanes
	Man-portable capability that can blow man-sized holes through walls, floors, and ceilings
	Man-portable, multi-spectral obscuration capability to obscure the average city street for the time it takes a squad to cross the street and breach and enter an adjacent building
	Sniper detection capability that works in all conditions
Combat Service Support (CSS) Enhancements	Quick, reliable method to expedite the resupply of consumables such as water, food, ammunition, and batteries to dispersed squads and teams without sacrificing momentum or unduly exposing personnel to enemy observation or fire
	Reliable method to expedite the resupply of fuels to vehicles without sacrificing momentum or unduly exposing personnel to enemy observation or fire

Although there are no specified requirements to improve the speed, agility, or "mobility" of any ground system, there are requirements to improve vehicle survivability and provide urban countermobility. The CSS requirement for accelerated resupply of water, food, ammunition and batteries could be approached using a vehicular solution, or improving an existing vehicular platform. The vast majority of mobility enhancements identified by the MNS, Concept for Future MOUT, MOUT ACTD and the Joint

Warfighter Science and Technology Plan pertain to improving the mobility of the individual Marine or soldier in the urban environment.

7.3.3 Urban Warrior War Game Assessments. In preparation for the UW AWE, the Marine Corps Warfighting Laboratory, then the Commandant's Warfighting Laboratory, sponsored a series of seminar discussions and war games to explore the nature and challenges of urban warfare. Unconstrained by the need for compelling or detailed rationale, these discussions enabled professionals to peer ahead to attempt to anticipate the future needs of urban warfare. The following recapitulates the key findings and insights about urban vehicle mobility for each iteration.[18]

7.3.3.1 Urban Warrior I War Game. The purpose of Urban Warrior I (UW I) was to expand the knowledge base and general understanding of the character and requirements of urban warfare, with particular emphasis on developing innovative operational approaches and identifying critical implementing technologies. The vignettes and their recommended capabilities are listed below:

- Urban Canyon – a 20x20 square block area of high-rise office and apartment buildings with a significant civilian population present
  - Multi-purpose unmanned ground vehicles (UGVs)/robots (weaponized, communications, sensing, decoys, navigation, etc.)
  - Armored personnel carriers (taxi) (converted tanks)
  - Fuel enhancers/additives
  - Ceramic engines/alternative fuels
- Underground – an extensive and complex subway system
  - Subterranean Assault Vehicle (variable wheel base)
  - Mine detection
  - Motorcycles
  - Multi-purpose unmanned ground vehicles (UGVs)/robots (weaponized, communications, sensing, decoys, navigation, etc.)
- Weapons of Mass Destruction, or WMD – a large, heavily fortified, deep underground facility used to store and produce WMD.
  - Multi-purpose unmanned ground vehicles (UGVs)/robotics
  - Deliver breaching materials
  - Robo-roaches (early warning capabilities)
  - Surveillance and reconnaissance

7.3.3.2 Urban Warrior II Wargame. Urban Warrior II (UW II) continued to examine and assess emerging UW concepts and capabilities. Building on UW I, the war game was a single-sided seminar war game, a Southwest Asia scenario, with a Marine Expeditionary Unit (MEU) executing selected missions around the mid-sized urban area. Three friendly force cells played out the scenarios. The mobility related capabilities and/or technology findings are as follows:

- Increased vehicular mobility (urban assault vehicle or lighter tank) to gain more maneuverability

- Use of indigenous transportation assets in order to better negotiate narrow streets and alleys (perceived better than HMMWVs which are about 8 feet wide), and reduces need for logistics
- Capability to treat, protect and evacuate casualties from urban environment
- Capability to maneuver within the city, including rapidly repositioning reaction forces
- Capability to conduct above ground movement between buildings and structures
- Air transportable fighting vehicle family. There is a need for a family of vehicles capable of internal transport in the MV-22. The family would include as a minimum, a weapons variant capable of carrying and employing heavy, medium and light machine guns, a C2 variant, and a logistics variant
- Remote surface/subsurface unmanned vehicle. This capability provides the ability to perform numerous functions using a small-unmanned platform. These might include resupply surveillance, and deployment of non-lethal munitions
- Cross-canyon mobility. This capability was identified to enable personnel the ability to cross from building to building, spanning the "canyon" between them. This will provide greater mobility to attacking elements
- AAAV recovery and logistics variants. Presently the fielding plans for the AAAV do not include recovery and logistics variants. Cell felt that to conduct OTH operations in an OMFTS situation, these variants were required
- Remote mine sensing. To conduct rapid surface operations, the MAGTF needs the capability to identify all types of mines, including surface and subsurface

7.3.3.3 Urban Warrior III Wargame. The purpose of Urban Warrior III (UW III) was to refine Urban Warrior concepts for tactical level operations and to develop a concept of operations/employment baseline for a follow-on UW Sea Basing War Game and other efforts. The focus of this game was on concept/capability exploration, not training of players. This war game featured the use of the Tactical Logistics Distribution System – Fast (TloaDS-F) model, an analytical tool that permits users to qualitatively and quantitatively examine logistic options, to help frame the sea-based logistics concept. No specific mobility related technologies or capabilities were defined in the assessment.

7.3.3.4 Urban Warrior IV Wargame. The purpose of Urban Warrior IV (UW IV)was to extend the examination of urban operational concepts to a more detailed level of tactical granularity, with particular focus on the dynamics of tactical decision-making in the urban environment. In particular the objectives were to look at the impact of improved communications and improved situational awareness in urban combat. No specific mobility related technologies or capabilities were defined in the assessment.

7.3.3.5 Urban Warrior V Wargame. The purpose of Urban Warrior V (UW V) was to "expand the scope of the Urban Warrior War Game series by exploring the operational dimensions of medical support and casualty evacuation in urban combat. This effort examined the use of a concept called the Multipurpose Health Service Facility (MPHSF), which lacked sufficient mobility to keep up with ground combat forces. A proposed follow-on action was to experiment with modifying current vehicles (HMMWV, 5-ton truck, LAV or AAV) to explore the mobile MPHSF concept.

7.3.3.6 Close Support End-to-End Assessment (CSEEA) MOUT Seminar War Game. The purpose of this war game was to examine and assess the integration of advanced concepts, capabilities, and technologies in a major urban campaign. Using a Northeast Asia scenario in the 2006 and 2014+ timeframe, the effort looked at four vignettes. These vignettes were:

- Urban Canyon – a 20x20 square block of high-rise office and apartment complex with a significant civilian population
- Underground – an extensive and complex subway system
- Mobile Strike – the movement of small but potent enemy mobile units throughout the city
- Bunker – large, heavily defended enemy position that included a deep underground command and control facility.

This assessment provided findings indicating that technology can enable, but not solve the problems posed by urban warfare. Given that, "the most precise weapon is the dismounted infantry," the most useful technologies, for the conditions of the war game, would be see-through and around technologies, multipurpose robotics/remote vehicles, and a suite of unattended sensors. When polled on system utility, players surveyed in war game identified the Light Armored Vehicle (a wheeled system) and the Bradley Fighting Vehicle (a tracked system) as the two most useful systems.

7.3.3.7 Summary. This collective wargaming effort helped shape the nature of the experimentation conducted by the MCWL in preparation for the Urban Warrior AWE. These efforts enabled the MCWL to focus the scope of their experimentation on those capabilities and technologies that feed perceived operational requirements. Not all participants addressed the posed tactical problems with the same approach or mindset. Nor was much of the planned experimentation leading up to the AWE able to look at the specific environments (urban canyon, bunker, etc.). The sense of these exercises is that there is a need for improved survivability in the form of unmanned surrogates, that do not risk lives, and protective capabilities that mitigate the lethality of the urban battlefield. Additionally, there are needs for (1) improved capabilities to proactively sustain life, by providing improved combat service support, and (2) improved capabilities to reactively treat injury by providing improved casualty evacuation support. Presently, ground vehicles provide this capability, however, the dynamics of the urban battlefield demand improvements to the current capability. In the war games where a "Red Cell" proposed threat counter-moves, mines and obstacles was commonly used to foil "Blue" movement. However, in the CSEEA, where the players were surveyed about major system utility in MOUT, the Combat Breaching Vehicle, Grizzly, did not appear as a candidate system for evaluation.

7.3.4 Mobility and Survivability Capabilities and Requirements. The requirements and capabilities for mobility and survivability for the ground vehicles under consideration, Light Armored Vehicle, Light Strike Vehicle, and Light Tactical Vehicle Replacement, as stated in their operational requirements documents are depicted in the following two tables.

Mobility Requirements

Requirement	Wheeled Systems		
	LSV	**LAV**	**LTVR (except M997 & M1097)**
Threshold Acceleration	Demonstrate acceleration of 0 to 48 kph (30 mph) in six seconds	Achieve acceleration of 0-20 mph (0-32.2 kph) in 10 seconds on a dry, hard roadway	Demonstrate acceleration of 0 to 48 kph (30 mph) in less than or equal to eight seconds
Objective Acceleration	Demonstrate acceleration of 0 to 48 kph (30 mph) in four seconds	Achieve acceleration of 0-20 mph (0-32.2 kph) in 6 seconds on a dry, hard roadway	Demonstrate acceleration of 0 to 80 kph (48 mph) in four seconds
Run flat capability	30 miles at 30 mph		30 miles at 30 mph
Turning Radius	Have a turning radius <= 25 feet curb to curb (threshold) 20 feet objective	Have a turning radius <= 70 feet curb to curb	Have a turning radius < 24 feet 10 inches curb to curb
Braking distance	Braking. Capable of being decelerated, stopped, held and controlled when ascending or descending grades up to 60 percent percent….	Brake from 20-0 mph in 35 feet (32.2-0 kph)in 10.7 meters) on dry, hard roadway [drift no more than 3 feet (.9 meter) left or right]	
Ground Clearance	Have a ground clearance of 38 cm (threshold) Negotiate an 18 inch (61 cm) step (threshold)		Negotiate an 18 inch (61 cm) step (threshold)

Table 7.3.4-A

Survivability Requirements

Protection Level Requirement	Wheeled Systems		
	LSV	**LAV**	**LTVR**
Chemical energy anti-armor weapon	No measurable survivability requirement is defined in the ORD	Protect by an onboard active protection system	Be capable of being fitted with removable ballistic protection kits to protect the crew and equipment from mine and fragmentation damage (objective)
12.7 armor-piercing (AP) ammunition		Protect 360° exposure, 0° obliquity, 300 meters range	
14.5mm AP ammunition		Protect, 0° obliquity, 500 meters range, exposure as practical	
7.62mm x 54R ammunition		Protect 360° exposure, 0° obliquity , 0 meters range	
152mm artillery fragment		Protect from an airburst at 50 feet	

Table 7.3.4-B

The mobility and survivability requirements of these ground vehicles do not incorporate specific criteria for employment in the urban environment. In fact, the turning radius of vehicles would best be described from "wall to wall," which would realistically portray the urban requirement. Although none of these are urban-only vehicles, in fact, the current HMMWV (LTVR) and LAV, when prudently employed, have performed admirably in urban environments. One veteran of operations in Somalia and Haiti had the following suggestions for improving the survivability of wheeled vehicles in urban operations:

- 'Clip-on' protective screens for use in urban areas, that degrade effects of 7.62mm caliber ammunition
- Land mine blast protection from below and the sides
- Rigid or semi-rigid screen to place around the cargo compartment of the vehicle to prevent pilferage
- Infrared identification signal capable of displaying different combinations of lights from above to the rear and (possibly) the sides
- Thermal viewer that operates using vehicle power [19]

These proposed improvements reflect a continuing concern with survivability, rather than mobility. The ability of "thin-skinned" combat vehicles to avoid lethal fires is contingent on their proper employment, and the presence of dismounted infantry to provide a screen against the threat.

7.3.5 Small Urban Vehicles. Based upon emerging tactics and techniques being prepared for the UW AWE, the MCWL doctrine conducted a Limited Technical Assessment (LTA) of candidate small urban vehicles, as part of the MCWL experimentation.[20] This was held during Limited Objective Experiment (LOE) One, which was conducted during April 1998, at Camp Lejeune NC. The objectives of the LTA were:

- Can we identify preferred small urban vehicle (SUV) characteristics for conducting resupply/medevac operations in urban terrain?
- Can we identify relative advantages and disadvantages of three different types of SUVs – the Grizzly-ATV, Gator, Helicopter Transportable Tactical Vehicle (HTTV) – as well as the HMMWV, in conducting resupply/medevac operations in urban terrain? (Pictures of vehicles are shown in Appendix A. (Photograph of Grizzly ATV is of current commercial version)
- Can we identify tactics, techniques and procedures for sustainment delivery teams (SDTs) to employ while using SUVs in urban operations

The measures of performance developed for the assessment were:

- Maneuverability
- Turning radius
- Speed on mobility course
- Maximum speed

- Helicopter internal transportation
- Payload capacity (maximum weight)
- Vulnerability on mobility course

Using a mobility course within the Camp Lejeune MOUT facility, the assessment was conducted, with each candidate vehicle being used for an equal series of runs. The runs combined the use of enemy snipers, some were conducted at night, and one run for each vehicle was made with a trailer attached. Based on the measures of performance, the following conclusions were drawn:

- Reduce vulnerability through increased maneuverability, using smaller, not faster vehicles
- There is a major trade-off between vulnerability and payload capacity (smaller, less vulnerable vehicles had less payload capacity than larger vehicles)
- The Gator was the most preferred vehicle, but payload capacity needs improvement (perhaps through an expanded cargo bed or trailer)

The assessment concluded that further study of SUVs was warranted. Additional measures of performance, such as casualty carrying capability, firepower capability, obstacle clearing capability and survivability were recommended to be evaluated in later iterations. Last, it was recommended that the tactics, techniques and procedures employed by the SDTs be refined and improved in subsequent experimentation. A portion of this experimentation was carried out during LOE Two.

7.3.6 Ground Maneuver during Limited Objective Experiment (LOE) Two. The purpose of LOE Two was to experiment with combined arms penetration and thrust operations. This LOE did experiment with new tactics, techniques and procedures employed by the SDTs. The experimentation produced the following observations, relative to vehicle employment in urban areas:

- Helo-transportable SDT vehicles provided substantial capability for both supply delivery and casualty evacuation
  - SDT was expanded from 6 Marines to 13, to provide some self-protection, and therefore improve survivability. Based on LOE 1 performance John Deere's Gator was the sole vehicle used
  - "Rover" Team changed from 2 vehicle (HTTV and hardback HMMWV) to 4 vehicle (2 hardback HMMWV, 1 highback HMMWV and 1 armored combat earthmover (ACE))
- Lightly armored vehicle (LAV and AAV) survival was problematic:
  - Once in the area (urban area) vehicles that moved little took a lot of casualties (mainly from heavy machine guns and rocket propelled grenades)
  - Conversely, when they continued to maneuver, survivability improved

Use of the Gator provided additional lessons learned:

- Use of a trailer with the Gator requires experienced driver due to difficulty in maneuvering vehicle with trailer in constrained urban space
- Gator needs capability to be secured; twice it was stolen during this LOE (vehicle was left unattended)
- Pallets used for resupply need runner or sled underneath to expedite movement by personnel after unloading

7.4 Lessons Learned. Urban combat since the Second World War has been documented and analyzed by U.S. researchers, to determine the future trends of urban fighting. Since the fall of the Berlin Wall, the dynamics of urban warfare have changed. Concerns about collateral or infrastructure damage, noncombatant involvement and less Euro-centric battlefield focus and the burgeoning urbanization of the world have fused to significantly complicate what was always a complex form of warfare. Examining the Israeli experience in Lebanon, the British experience in Northern Ireland and the recent Russian actions in Chechnya, the MCIA recognized three common themes:

- Operations primarily occurred in urban environments, or among large concentrations of civilians
- Conflict was against irregular forces, "fighters" rather than soldiers, in the conventional sense
- Local fighters were well armed with assault rifles, heavy machine-guns, rocket-propelled grenades, mortar, light artillery and man-portable air defense weapons

The dramatic results of recent urban engagements, especially those in Somalia and Chechnya underscore the general trends of urban combat, and are reflected in the recently published Marine Corps doctrine. From a variety of sources, the following lessons learned below apply most directly to the employment of ground vehicles in urban combat. Many of these lessons are complementary.

Lightly protected armored vehicles are of limited value in urban terrain

In the last days of the 1973 Arab-Israeli War, the Battle of Suez City was fought as the IDF attempted to encircle the Egyptian Third Army, which was trapped on the east bank. After a series of airstrikes, the IDF attempted a mounted assault into the city. McLaurin notes that, "Following airstrikes, the 217th Brigade's attack quickly bogged down on the northern outskirts in the face of Sagger missile, tank and antitank gun fires, Here they stopped to await the hastily attached infantry....As the lead armor battalion entered the second of the three road intersection objectives it was met by devastating fire. The Egyptians engaged with Sagger missiles, RPGs, ZU-23 AA guns, antitank grenades thrown from balconies, and small arms. All tank commanders in the lead battalion were killed or wounded. Disabled vehicles blocked the road. Vehicles veered into the narrow side streets often became trapped. The survivors of the leading armor force reformed and pressed on to its other objectives...."[21]

During the Battle for Tyre, June 1986, during Israel's *Operation Peace for Galilee*, handheld antitank weapons diminished the utility and combat effectiveness of lightly

armored vehicles. McLaurin writes, "From the initial skirmishes outside Tyre to the ambush at al-Bass crossroads to the fighting in the camps, the RPG certainly made itself felt. A number of tanks were knocked out by RPGs both in and outside the city. RPGs proved more devastating yet to APCs (armored personnel carriers). Later in the war the IDF (Israeli Defense Force *sic*) seems to have been more successful at keeping the APCs out of combat situations precisely because of their great vulnerability to the ubiquitous RPG."[22]

After the Battle for Tyre, during the Battle for Beirut, Israel infantry moved primarily on foot due to the vulnerabilities of the M113 APC. In some IDF units, soldiers were so terrified of the possibility of engagement by RPGs that they either rode on top, or walked beside the vehicle. During the fighting in Beirut, armored personnel carriers were used only to carry supplies to advancing infantry, always halting 100 meters behind enemy (*sic*) lines. In addition to their vulnerability to RPG fire, the M113 was found wanting due to the (1) limited ability to provide suppressive fire – their machineguns were unable to sufficiently elevate to engage upper story targets; (2) vulnerability of crew members manning outside mounted machineguns to sniper fire; (3) lack of maneuverability in roads and alleyways of refugee camps.[23]

Vehicles, including tanks and armored personnel carriers cannot operate in cities without extensive dismounted infantry support

During the Battle for Grozny, the Russian Army attempted to seize the city on 31 December 1994. Lester W. Grau notes that, "They tried to do it with tanks and personnel carriers but without enough supporting infantry....But, tanks and personnel carries, in the city without dismounted infantry support, were easy targets to antitank gunners firing from the flanks or from above. The initial Russian armored columns were swallowed up in the city streets and destroyed by Chechen gunners. After losing 105 of 120 tanks and personnel carriers the Russians fell back to consolidate for a long, building-by-building battle."[24] News reports from the scene recounted that the main attack was aimed at the railway station, located several blocks southeast of the Presidential Palace. Fierce resistance forced the Russians to withdraw from the city center and regroup. Heavy ground fog prevented Russian helicopters from providing fire support. The 131st Motorized Rifle Brigade sustained horrific losses. Only 18 of its 120 vehicles escaped destruction during the battle, and virtually all of the brigade's officers were killed. One officer who survived the battle stated that he was under fire from every direction, while engaged near the train station. Under fire from grenades, snipers and mortar, his unit received none of the requested supporting fires. A correspondent counted seventeen burned-out tanks and armored vehicles in front of the railway station.[25] In this instance the Chechens elected to permit the Russians to advance through the suburbs, choosing to engage them in the constricted spaces near the train station and Presidential Palace.

Vehicles require armored protection and self-protection capability to operate in the urban environment that differs from the kind of protection provided for fighting on the open battlefield

In Chechnya, the need for full dimensional armor protection became evident. The constrained urban environment provided anti-armor engagement opportunities against the upper surfaces of infantry fighting vehicles (IFVs) and tanks, where armored protection is non-existent. Russian assessments of their damaged vehicles revealed that the majority of lethal hits against tanks and IFVs occurred on their turret roofs and engine decks, as well as from the rear. The Russians outfitted some of their armored vehicles with wire mesh cages, providing a standoff of between 25 and 30 centimeters from the chassis. The cages can defeat the shaped charge warhead of the RPG-7, as well as provide protection against a Molotov cocktail or bundle of antitank grenades.[26] Likewise, the limitations on their tanks and infantry fighting vehicles to sufficiently depress and elevate their organic weapons enabled the Chechens to ambush them from basements and rooftops without serious danger of counterfire.

Rocket Propelled Grenades (RPGs) are ubiquitous and effective in urban warfare

The Palestine Liberation Organization (PLO) employed RPGs on a wide scale. Each group of three to six fighters was equipped with an RPG. Although ineffective against IDF Merkava tanks, RPGs were lethal enough to cease using M113 APCs and trucks near the front lines. PLO accuracy was often poor, but RPGs were effective as area weapons against troops in building, behind barricades, or as harassment fires. The range of the weapon was valuable in urban settings, and was appropriate for short-range engagements.[27]

During the Battle of Mogadishu, Somali gunmen used RPGs at close range to attack vehicle convoys with deadly effect. HMMWVs were hit repeatedly. Many of these hits had catastrophic results causing numerous fatalities and injuries.[28] Somali fighters were also able to use RPGs to shoot down U.S. helicopters.[29]

Obscuration improves survivability in urban combat, but carries operational disadvantages

The Russians used smoke and white phosphorus extensively to screen the movement of troops and vehicles during the fighting in Grozny. Between twenty and twenty-five percent of their artillery and mortar fire was obscuration rounds.[30]

During the Battle of Beirut, the IDF selectively used smoke to prevent PLO use of RPGs and light weapons in ranges of 100 to 300 meters from advancing forces. This was considered effective. Smoke was also used to relieve pressure on forces under fire.[31] The disadvantages were that smoke impaired IDF driver performance, impeded visual communications between attacking forces, and retarded the advance of the force.

Mines and boobytraps present serious tactical difficulties in urban operations

During the Israeli invasion of Lebanon in 1982, mines were used by the PLO on main avenues of approach into Beirut, along the coastal highway, and in the Corniche and in certain sections of the city. In Beirut and Sidon their use was frequently haphazard and

frequently the mines were laid in plain view. Nonetheless, their presence did serve to slow the attacker. There were cases of mines being properly laid, and their use required the IDF to have sappers cut lanes through the minefields.[32] The PLO used obstacles, barriers and barricades, frequently in combination with mines, to block roads and force IDF traffic onto mined routes. This situation required the IDF to employ armored bulldozers to clear barricades. Bulldozers were also used to bury bunkers, build firing positions, widen and grade roads, and create bypasses within the cities.[33]

During French de-mining efforts in Beirut, after the Israeli invasion, the magnitude of the accumulation of mines and boobytraps laid by the PLO and the Christian forces became evident. The report the French Army issued observed minefields in urban areas like Beirut developed into complex obstacle zones, consisting of mines, dispersible bombs, sub-munitions, explosives and incendiaries. Furthermore, even under relatively benign conditions, mine detectors were useless in an urban zone. Last, engineers operating in an urban zone must have armored earthmoving equipment, in significant numbers, to clear modern urban obstacles.[34]

In Chechnya, trucks lacking armor protection for the cab proved highly vulnerable to mines, and to ambushing Chechen fighters. Anti-personnel and anti-tank mines destroyed approximately 600 trucks and unarmored vehicles during the fighting. High casualties resulted from the absence of protective kits on support vehicles. Although not all of these casualties were incurred in an urban environment, this vulnerability is magnified in the urban battlespace.[35]

In Mogadishu, the prevalence of the Somalis to mine barricades often required that the barricades be disassembled by dismounted troops. During the Battle for Mogadishu, this caused a relief column to stop and exposed dismounted soldiers to heavy fire while a barricade was dismantled.[36]

Urban warfare severely penalizes poorly trained units

In the Russian campaign into Chechnya, the lack of training for units ordered into combat bordered on criminal negligence.

In 1993, during the Battle of Mogadishu, the Rangers who fought valiantly against overwhelming numbers, suffered needlessly, partly due to the lack of training of the vehicle drivers. During the attempt by the convoy to reach the crash site of Super 61 (CW Cliff Wolcott's UH-60), the relief convoy of HMMWVs and 5-ton trucks was repeatedly ambushed by..."Somalis throwing up roadblocks and preparing ambushes. A group of about 15 gunmen were running along streets parallel to the convoy, keeping up because the two five-ton trucks and six humvees (*sic*) were stopping and then darting across intersections one at a time. This gave the gunmen time to get to the next street and set up to fire at each vehicle as it came through."[37] Inexperienced Ranger drivers continued to stop after crossing an intersection, exposing the next vehicle to crossfire, and as soldiers dismounted during the convoy to provide security, they were exposed to even greater fire.

All-wheel drive and durable run-flat tires are absolute necessities in urban combat

During the Battle of Mogadishu the HMMWVs proved their mettle, absorbing multiple RPG hits, and continuing to move with all tires flat.[38] During the movement of convoy carrying the Somali prisoners, the convoy's HMMWVs continued to move despite broken axles, multiple small arms hits, and were able to crash through roadblocks and remain upright.

Mobility of a convoy is limited by the least capable vehicle

The American relief attempts during the Battle of Mogadishu were convoys consisting of HMMWVs and 5 ton trucks. The inability of the 5-ton trucks to negotiate roadblocks and obstacles restricted the routes available to the rescue convoy.

7.5 Synthesis. The lessons learned about vehicle employment in past urban conflicts affirm current doctrine and validate the requirements for operational capabilities. Urban combat demands a combined arms approach. Dismounted infantry will continue to be the base unit for task-organized assault teams, that will often be integrated with armor, light armor, engineers and artillery at the battalion level and below. Attempts to use vehicle-centric mobile forces were attempted by the Israelis and the Russians, and were not operationally successful. Under fire, the survivability of individual vehicles is as much a function of tactical employment as it is of the particular system characteristics. Nonetheless, the multidimensional exposure of vehicles to lethal fire from above, on and below the horizontal plane of the battlefield increases the need for improved survivability and increases the need to reduce "dead space" of organic weapons. The close ranges in typical urban combat mandate the absolute reduction of potential deadspace for vehicle employment, around the entire circumference of the vehicle. The effect of the urban terrain is to funnel tactical operations along narrow mobility corridors. The requirement to move forces along these narrow corridors increases the need for countermobility capabilities.

7.6 Urban Threat. On a national basis, the threat to the success of any U.S. military intervention is to subvert the credibility of the rationale for the operation, and to undermine the validity of the assumptions that are made to justify the operation. Where national security is not at stake, one current underlying truism is that Americans are apt only to support the use of military force if there is some assurance of "light" casualties. This expectation was created by the minimal amount of casualties sustained during the Persian Gulf war. The presumed validity of this tenet was upheld by the rapid American disengagement after the Battle of Mogadishu, where eighteen U.S. soldiers were killed, and seventy were wounded. The urban threat is magnified by potential adversary's disregard for the law of war and the use of tactics that bait U.S. forces into disregard for international law. Potential adversaries understand these phenomena, and will seek to exploit it in future confrontations. In the urban environment, which is acknowledged to

be infantry intensive , the relevancy of recent urban combat is applicable to future urban threats.

In general, the threat to U.S. systems is aggravated in the urban environment. U.S. systems, capable of engaging targets at long distances with high probabilities of kill, are less effective in urban settings. The preponderance of U.S. systems are optimized to operate under general purpose conditions, and in fact, U.S. Marine systems are designed for expeditionary conditions, which until recently, have not been overly concerned with the urban environment. Therefore, when the capabilities of potential adversaries are examined through the lens of the urban environment, a different view of the threat emerges. It is not surprising that the urban threat in the foreseeable future resembles the historical threat from the past. Systems and capabilities that affected the Israeli military in 1982, the Russian military in Chechnya in 1994, and the U.S. military in Somalia, in 1994 will be manifest in the future.

The interaction between threat systems on the urban battlefield is similar to the interaction of threat systems on an open or less constrained battlefield. However, the urban environment affects the ability and opportunities of an enemy to use a system. The probability of encountering threat systems and their effectiveness is a function of the adversary's doctrine, tactics and density of the threat systems on the battlefield. Contemporary enemies have been willing to use human shields, use both sides of a street to ambush from, in effect shooting into each other, and other seemingly irrational techniques to engage targets. Factoring in the potential density of threat systems, typical close engagement ranges, close range effectiveness of threat systems, and the need to use mobility corridors, the following assessment reflects the general significance of threat systems against vehicles in an urban environment:[39]

1. Rocket Propelled Grenades
2. Heavy Machine Guns (12.7mm and above)
3. Mines
4. Small Arms (below 12.7 mm)
5. Anti-tank guided missiles
6. Artillery and Mortars
7. Multiple Rocket Launcher

7.6.1 Weapons Effectiveness. The most comprehensive study of the relationship between weapons effects and casualties in the urban environment is detailed in an analysis of the Israeli casualties during Operation Peace for Galilee.[40] This study, which compared urban casualties against casualties sustained in non-urban fighting during the same campaign, developed a breakdown of casualties in the force. This study reveals casualties to the force, which was largely dismounted, for the battles in Tyre, Sidon and Beirut – after the bad experience with using M113s.

Weapons Effects: Artillery, 105mm, 155mm, and the range of field mortars, is the most significant weapon for causing casualties in the urban combat environment (86% of all injuries) (Table 7.6.1). The risk of being injured by artillery in an urban environment was

20 times higher than in non-urban battle. Troops in APCs were at greater risk to injury from Rocket Propelled Grenades (50mm, 90mm, and 120mm) (RPG) in urban than non-urban battle. SAGGER ATGW missiles caused more injuries in non-urban combat (Table 7.6.2). This information reinforces the notion that short-range, relatively unsophisticated weapons, such as RPGs, cause more casualties in urban areas, than longer range, guided or technically advanced systems.

Casualties by Artillery and Other Weapons

System	Terrain					
	Urban		Non-Urban		Total	
	Number	Percent	Number	Percent	Number	Percent
Artillery	142	86.6	99	23.1	241	40.6
Other	22	13.4	330	76.9	352	59.4
Total	164	100.0	429	100.0	593	100.0

Derived from IDF operations during *Operation Peace for Galilee*

Table 7.6.1

Casualties by Anti-tank Weapons

System	Terrain					
	Urban		Non-Urban		Total	
	Number	Percent	Number	Percent	Number	Percent
RPG	16	88.9	14	62.4	30	58.8
SAGGER	2	11.1	9	38.6	11	41.2
Total	18	100.0	23	100.0	41	100.0

Derived from IDF operations during *Operation Peace for Galilee*

Table 7.6.2

7.6.2 Urban Countermobility Threat. The lessons learned suggest that mines and obstacles, combined with the constricted nature of urban terrain, nullify mobility, and can significantly threatens the survivability of vehicles and dismounted troops. The requirement to clear mines and obstacles causes forces behind the obstacle clearing detachment to halt while the clearing is conducted. The constricted nature of the terrain can forbid bypasses, and forces vehicles to halt and troops to dismount and seek cover and/or concealment. Dismounted troops may be able to find cover in or around buildings, but without overhead cover, become vulnerable to sniper, artillery and mortar fire. Vehicles become exposed to RPGs, incendiary devices such as Molotov cocktails, and heavy machinegun fire from above on and below the street. Once this deadly series of events is set into motion, the necessity to evacuate wounded and resupply forces in contact only increases the amount of traffic already on constricted throughways. Often, potential bypasses left by the enemy will only provide another urban ambush opportunity. Improving the mobility characteristics of ground vehicles may provide a marginal ability

to cope with certain obstacles, but does not address mines. Countermine capability significantly affects the mobility of the force in the urban environment.

7.6.3 Future Threat Capabilities. The potential for the spread of more lethal systems continues to grow. The following technologies are being proliferated, and may directly increase the threat to vehicle systems operating in the urban environment: [41]

- New munitions such as fuel air explosive (FAE), enhanced blast, intense light, and other improved ballistic technologies
- Systems with interchangeable warheads, some designed for MOUT combat
- Precision-guided munitions
- Robotics
- Elevated gun systems
- Day or night targeting
- Improved engineering abilities to breach or emplace obstacles
- Soft-launch hand-held anti-tank and flame weapons
- Non-lethal incapacitating chemical or biological agents by used conventional forces
- Improved communications

8.0 ASSESSMENT

The assessment of emerging operational concepts, current doctrine, mission needs statements, current capabilities, survivability and lethality data, projections for the growth of urban areas, government provided scenarios and a variety of lessons learned from diverse sources provides the following recommended improvements for the urban mobility capabilities of the wheeled vehicle fleet:

- Improved countermine and obstacle clearing capability
- Improved survivability (to degrade effects of chemical and kinetic threats, and enhance self-protection capability)
- Improved ability to furnish close combat service support (sustainment and casualty evacuation)
- Improved agility (turning radius, ground clearance, improved run flat capability, acceleration)

The urban battlespace demands credible countermobility capability. The ground combat element of the MAGTF must be able to maintain the momentum of the offensive in urban operations. Within urban areas, vehicles are especially susceptible to mines and the effects of obstacles covered by fire. Threat systems have increased lethality against stationary targets, or vehicles slowed by mines or obstacles. The growth of shantytowns adjacent to or within existing urban areas reinforces the need for countermobility. These areas present a more complex obstacle negotiation and navigation problem than conventional built-up areas and represent a growing segment in the inventory of urban terrain. This is especially true for the developing world within the littorals. The need for countermobility capability is preeminent to improving overall urban mobility.

The urban battlespace is resource intensive. Typically, it has generated a need for increased ammunition, supplies and the concomitant requirement to evacuate casualties. The inability of a force to resupply or evacuate casualties degrades the mobility of the entire force. Improving the capability of the existing fleet to accommodate field expedient resupply or casualty evacuation operations is significant for urban and conventional operations. Any new vehicle introduced should have the flexibility to be configured to perform both tasks.

The vertical dimension of the battlespace increases vulnerability to threats from above, on and below the horizontal plane, or street surface. In an environment of close engagement ranges, the amount of "dead space" in which a vehicle mounted weapon can not engage targets increases the vulnerability of the vehicle. Enhancements, which minimize dead space, improve vehicle survivability in the urban environment. Similarly, most lightly armored vehicles are least protected on their top surfaces. These surfaces are exposed in urban environments from the second story and above, and from rooftop vantages. Improvements, which reduce the lethality of threat systems from above or below the surface of the battlespace, are needed to improve survivability.

Wheeled vehicle employment in the urban environment must benefit from the insight provided by timely intelligence preparation of the battlefield. This doctrinal process, described in FM34-130, *Intelligence Preparation of the Battlefield*, requires commanders to include information about the width and direction of mobility corridors into their tactical plan. This precaution should minimize the occurrence of vehicles being unable to travel or turn within roads suddenly too narrow, or steep. Automotive engineering improvements resulting in tighter turning radius (wall to wall), higher ground clearance, improved acceleration, and better run-flat tires, will upgrade the mobility of the force. Potential improvements in these areas are useful for conventional "open terrain" and urban operations. Without improvements in countermobility and survivability, it would be difficult to justify improving any of these areas on the basis of urban operations alone. The degree of contribution that improvements in each of those areas would bring to combat effectiveness in urban operations is scenario and threat dependent. Simulation excursions may provide some insight as to which potential improvement offers the most combat capability.

MOUT will continue to be infantry intensive. The dismounted Marine rifleman is the "precision weapon" of the battlespace. The inability of the individual rifleman to freely move about the urban battlespace is the greatest impediment to implementing maneuver warfare in MOUT. In combat, dismounted infantry will continue to be required to advance with and screen ground vehicle movement in MOUT. Marine Corps ground vehicles provide a significant portion of combat power for the MAGTF in MOUT, and can contribute to enhancing the mobility of the dismounted rifleman. However, the underlying premise remains that dismounted infantry will continue to be the base unit for movement in urban operations. Apart from movement to contact operations, when enemy contact is considered remote, or during convoy operations to and from urbanized terrain, only in the most rare circumstance will vehicular forces be autonomously employed without the benefit of infantry protection.

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http://www.geocities.com/Pentagon/6453/ This is the MOUT Homepage, founded and maintained by Mr. Dave Dilegge. It contains an abundance of MOUT oriented material, lessons learned and tactics, techniques, and procedures submitted by site visitors. The page is unofficial - maintained on a personal site - and is updated frequently. Though the page is Marine oriented, much of the information applies across service lines. The site index and index guide can be found at the bottom of the homepage.

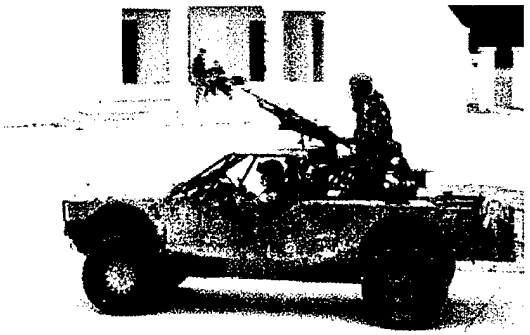
ACRONYMS AND ABBREVIATIONS

AAAV	Advanced Amphibious Assault Vehicle
AAV	Amphibious Assault Vehicle
ACE	Armored Combat Earthmover or Aviation Combat Element
ACTD	Advanced Concept Technology Demonstration
AP	Armor Piercing
APC	Armored Personnel Carrier
ATV	All Terrain Vehicle
ATGW	Antitank Guided Weapon
AWE	Advanced Warfighting Experiment
C2	Command and Control
C4I	Command, Control, Communications, Computers and Intelligence
CSEEA	Close Support End to End Assessment
CSS	Combat Service Support
DTO	Defense Technology Objective
FM	Field Manual
GCE	Ground Combat Element
HMMWV	High Mobility Multipurpose Wheeled Vehicle
HTTV	Helicopter Transportable Tactical Vehicle
IDF	Israeli Defense Force
IFV	Infantry Fighting Vehicle
IPB	Intelligence Preparation of the Battlefield
LAV	Light Armored Vehicle
LOE	Limited Objective Experiment
LSV	Light Strike Vehicle
LTA	Limited Technical Assessment
LTVR	Light Tactical Vehicle Replacement
MAGTF	Marine Air-Ground Task Force

MCDP	Marine Corps Doctrinal Publication
MCIA	Marine Corps Intelligence Activity
MCWL	Marine Corps Warfighting Laboratory
MCWP	Marine Corps Warfighting Publication
MOBA	Military Operations in Built-up Areas
MOUT	Military Operations on Urbanized Terrain
MNS	Mission Needs Statement
MPHSF	Multipurpose Health Service Facility
OCE	Operational Capability Element
OH	Operational Handbook
ORD	Operational Requirements Document
OSD	Office of the Secretary of Defense
OTH	Over the Horizon
PLO	Palestine Liberation Organization
RPG	Rocket Propelled Grenade
SDT	Sustainment Delivery Team
SUV	Small Urban Vehicle
TloaDS-F	Tactical Logisitics Distribution System-Fast
UGV	Unmanned Ground Vehicles
UN	United Nations
UW	Urban Warrior
WMD	Weapons of Mass Destruction

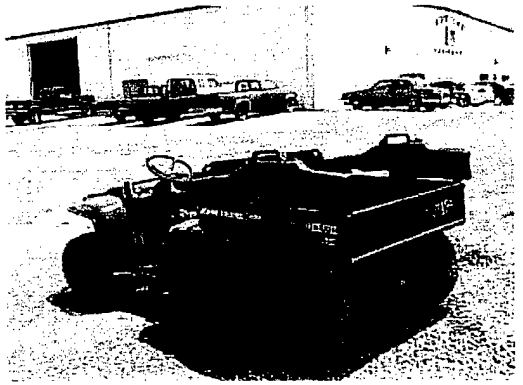
Appendix A

Candidate Systems for Mobility Limited Technical Assessment



Helicopter Transportable Tactical Vehicle (HTTV)

Grizzly All Terrain Vehicle (ATV)



John Deere GATOR

B-1 INTRODUCTION This appendix addresses analysis focused on the possible identification of vehicle mobility improvements that can lead to better capabilities for conduct of urban operations. It will cover analysis approach, research results, visualization gaming results, conclusions, and recommendations.

B-2 APPROACH The basic approach to this analysis supporting the study on military operations on urbanized terrain (MOUT) consists of:

- **Research.** This covered lessons learned during the period World War II to more modern operations in Somalia and Chechnya. The research effort also examined doctrinal publications on MOUT and allied topics, as well as the Defense Science Board report on military operations in built-up areas (MOBA). The research also benefited from discussions with in-house personnel with military operational backgrounds (some of whom are currently working in the urban operations area). The research was distilled into items identifying a baseline mode of operation and areas needing improvement.

- **Visualization Type Gaming.** This involved having operationally experienced personnel visualize an urban setting and identify applicable considerations.

    - The visualization gaming begins by creating a context through consideration of:

        - The combat intensity-urban density relationship. This is a plot of combat intensity from minimal combat through high intensity versus urban density from rural to densely built-up cities.

        - Vehicle roles as described in current doctrinal literature.

        - Current approach to urban operations (the baseline mode of operations).

        - Areas for improvement in urban operations

    - Based on the foregoing contextual material, the visualization gaming personnel identified candidate vehicular mobility improvements that might improve urban operations. The candidate improvements were considered as follows:

        - Visualize improvement in urban operations

        - Consider the effectiveness of the candidate improvement

- Identify whether or not the improvement is unique to urban operations or beneficial across the entire urban-rural continuum

- Estimate the proportion of operations in which the improvement adds effectiveness

- Characterize the candidate improvements in the light of the game results

- **Analysis Conclusions.** Identify promising candidate vehicle mobility improvements.

- **Recommendations.** Indicate improvements that should be pursued and suggested action (engineering analysis, purchase and apply to X vehicle, etc.)

B-3 RESEARCH

- **Baseline Mode of Operations**

  •• Background. In general, in cases where the natural terrain, vegetation, and absence of man-made objects provide minimal cover and concealment for opposing forces, vehicle-mounted friendly troops can acquire and engage the opposing force at ranges that do not offer the opponent high likelihood of killing or damaging the friendly vehicle. The converse of these conditions, which is termed close terrain (terrain that is forested or has many man-made structures or is tightly compartmented in a geographical sense), does offer cover and/or concealment for an enemy to attack vehicle targets at ranges that may offer relatively high single shot kill probabilities. The larger presented area a vehicle provides, the higher the probability of hitting it. Under these close range conditions, one way to avoid being hit and possibly killed is to greatly reduce the size of targets presented to the enemy as well as periods of exposure. This is best achieved by using dismounted infantrymen who are relatively small targets with very flexible movement and target engagement capabilities and the ability to occupy much smaller covered positions than vehicles. These general considerations underlie current doctrine for conduct of urban operations.

  •• Figure B-1 shows a plot of combat intensity versus urban density. The annotations are generally reflective of the reasoning in the preceding paragraph, which conforms to current doctrine for military operations in built-up areas.

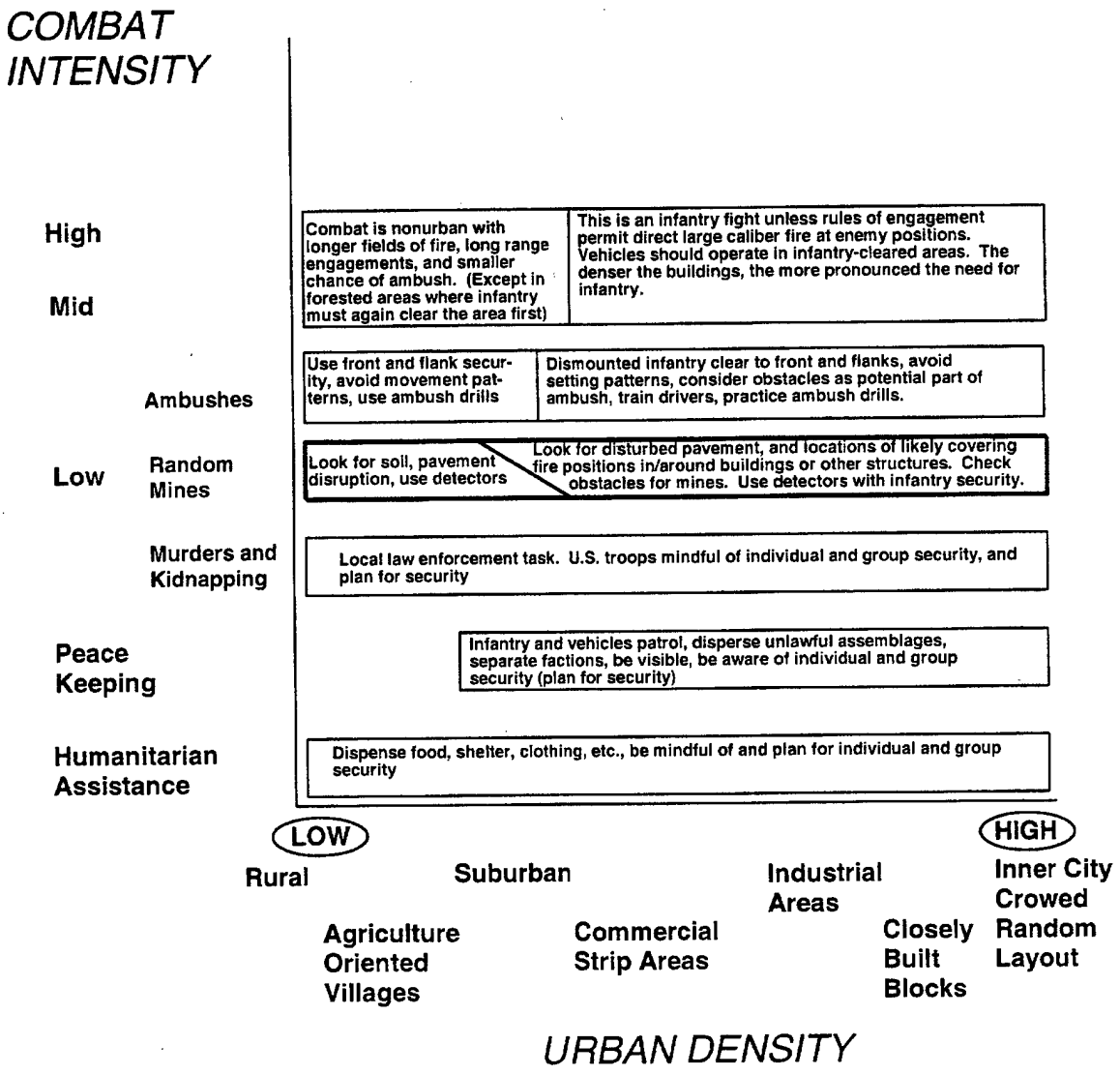


Figure B-3

- Mode of Operations. As suggested by Figure B-1, current doctrine for urban operations of higher intensity or in environments where ambushes are likely, involves use of infantry to clear areas before vehicles are employed. Wheeled vehicles are generally used in a combat service support role, unless rules of engagement permit assault fires by vehicle mounted weapons (usually large caliber).

- **Items Requiring Improvement.** Paragraph 8 of the basic report addresses a number of improvements which further the mobility of the wheeled vehicle fleet. These items include improved countermine and obstacle clearing capability, improved survivability, improved ability to furnish close combat service support, and improved agility. While all of the foregoing may promote

improved mobility either directly or indirectly, the improved agility item is the only one that addresses inherent vehicle mobility attributes. One might stretch the point and include improved countermine and obstacle clearing, if a proposed vehicle improvement included a vehicle-mounted tool, such as a blade, for removing obstacles; however, obstacles are often mined or booby trapped and covered by fire, so this would appear to be a task for a dedicated vehicle. Consequently the areas requiring improvement resulting from research include:

- Reduced turning radius
- Improved ground clearance
- Improved run flat capability
- Improved acceleration

B-4 VISUALIZATION GAMING

- **General.** In creating the context for the visualization gaming, three of the extremes of the combat intensity-urban density plot were initially considered: high intensity, high density; low intensity, high density; and high intensity, low density. Low intensity, low density conditions were not considered beyond the conclusion that mobility challenges will generally be minimal with few requirements to leave the road net.

- **Reduced Turning Radius.** Turning radius was reviewed in a wheeled vehicle context. Analysis resulted in the following considerations:

  - Changes in turning radius have impact on vehicle dimensions. In general, to have a smaller turning radius, a greater amount of inboard dimension (mainly width) must be dedicated to wheel movement, or the vehicle must be wider. In the current air transportability climate, wider is <u>not</u> better. It is clear that changes to turning radius must be part of overall vehicle trade-offs and may not be easily implemented.

  - Reduced turning radius may help a vehicle to maneuver to avoid being engaged. Figure B-2 depicts a vehicle route of movement down a street. The vehicle may be engaged and missed by an RPG gunner in window #1 and is able to reach a covered position by backing into a narrow alley.

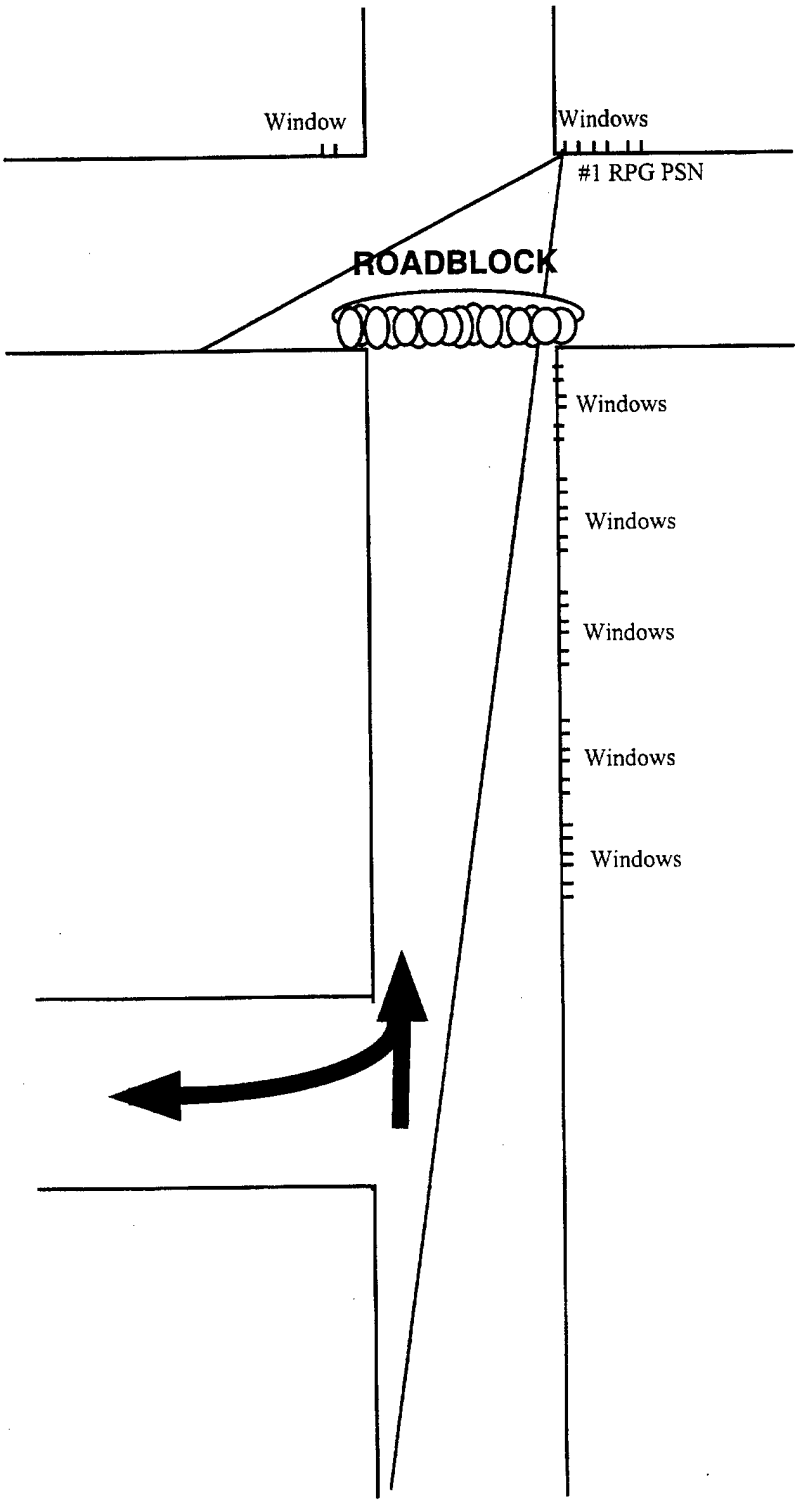

Window
Windows
#1 RPG PSN
ROADBLOCK
Windows
Windows
Windows
Windows
Windows

Figure B-2

•• Figure B-3 depicts a vehicle route of movement down a street that turns out to be covered by fire from two windows. The figure depicts a U-turn maneuver which would be undesirable under conditions of

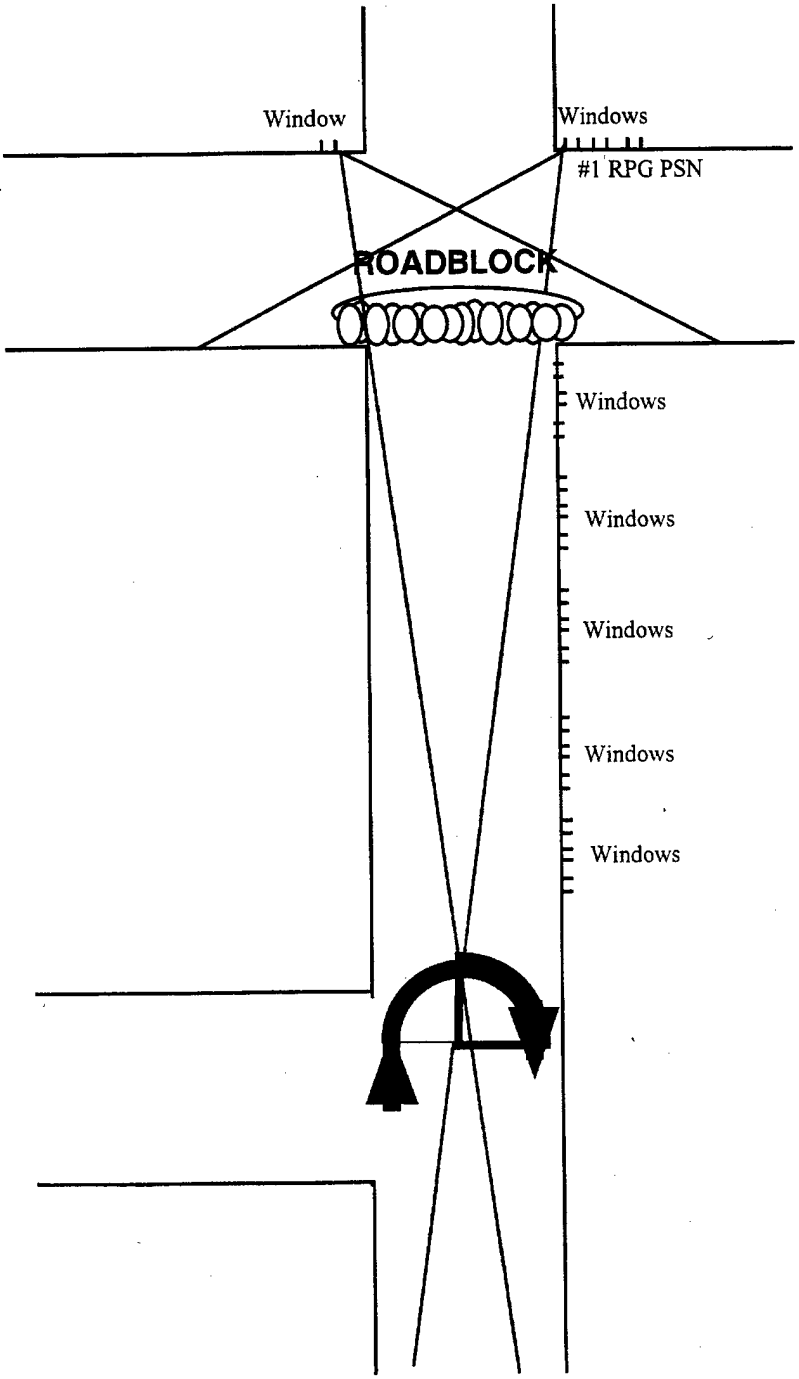


Figure B-3

potential engagement. The U-turn transitions the vehicle from

50

a frontal target (to the threat) to a side target (higher Ph) and then to a rear target with poor vision toward the threat weapons. If the turning radius is not quite small enough, additional exposed maneuvering would be required.

- If the environment is that of low intensity combat and the vehicle has made a wrong turn, decreased turning radius is helpful in turning around.

- In rural areas with wooded conditions or areas with sunken roads, such as one finds in Western Europe, reduced turning radius would be beneficial as well.

- Reduced turning radius would be helpful in maneuvering vehicles on shipboard.

- If reduced turning radius could be achieved without having to trade-off some other vehicle feature, it would offer benefit nearly all the time.

- Since reduced turning radius really does have vehicle trade-off implications, it should buy its way onto a vehicle in competition with other features.

- **Improved Ground Clearance.** Improved ground clearance was also considered in a wheeled vehicle context. Analysis resulted in the following considerations:

  - Improved ground clearance would help in urban operations where streets are rubble strewn or in cases where there are rubble barriers known to be clear of mines or booby traps.

  - There are a number of conditions in a rural environment in which improved ground clearance would improve vehicle agility. These include conditions of deep mud or snow, areas with tree stumps or rocks, and in negotiating ditches.

  - Increases in ground clearance have potential for affecting other vehicle attributes such as center of gravity and suspension performance. Increases in ground clearance should be considered from a perspective of their impact on other vehicle attributes.

  - Similar to the condition with turning radius improvement, increases in ground clearance are not unique to urban operations and do have tradeoff implications. As with turning radius, ground clearance should buy its way onto the vehicle in competition with other vehicle features.

- **Improved Run-Flat Capability.** Analysis of improved run-flat tires resulted in the following considerations:

  - Run-flat tires are desirable under all operational conditions under which tires are likely to become damaged and potentially deflate. The provision of run-flat tires that maintain their profile longer (more miles) than current versions is not a major improvement unique to the urban environment. In fact, in current doctrine, urban conditions may well subject tires to less damage from engagement by fire than in rural environments. It is recognized that rubble and glass shards in the urban environment do damage tires.

  - If the government can obtain better run-flat tires, for the same cost as current run-flat tires, it should procure them. If the better run-flat tires cost more than current versions, the improved item should buy its way onto the vehicle similar to turning radius and ground clearance.

- **Improved Acceleration.** Improved acceleration is related to power to weight ratio, torque delivered to the drive train, suspension, tires, and other factors. In the context of this analysis, acceleration is taken to mean an achievable increase in cross-country acceleration. Acceleration is a key element in vehicle agility. Analysis of acceleration surfaced the following considerations:

  - Improved acceleration means improved dash capability from one covered position to another, minimizing exposure to threat fire. Fundamental vehicle movement techniques involving a base of fire and a maneuvering element would be enhanced by having briefer exposure times for the maneuvering element. These movement practices would be used more often in rural areas, but might be used in built-up areas that afford fields of fire to the base of fire element. Improved acceleration would help vehicles to transit dangerous cross streets quickly.

  - Although agility is usually addressed in terms of forward movement, there are instances in which vehicle rearward or reverse movement can benefit from increased agility.

    - A weapon-equipped vehicle can engage a target, and having greatly increased its signature by firing, can rapidly back to a covered position. It can then occupy an alternate position and fire again. This is a standard engagement approach which might be found in either rural or urban conditions and which is enhanced by improved rearward acceleration.

    - In urban settings with streets that canalize movement, there are often limited movement options if a vehicle on the street is

engaged. Figure B-4 depicts a street schematic representative of a dense city layout. A combat intensity level at least high enough to make ambushes likely is assumed. Also roof tops are assumed to be unlikely firing positions, because of construction and probability of attack from the air.

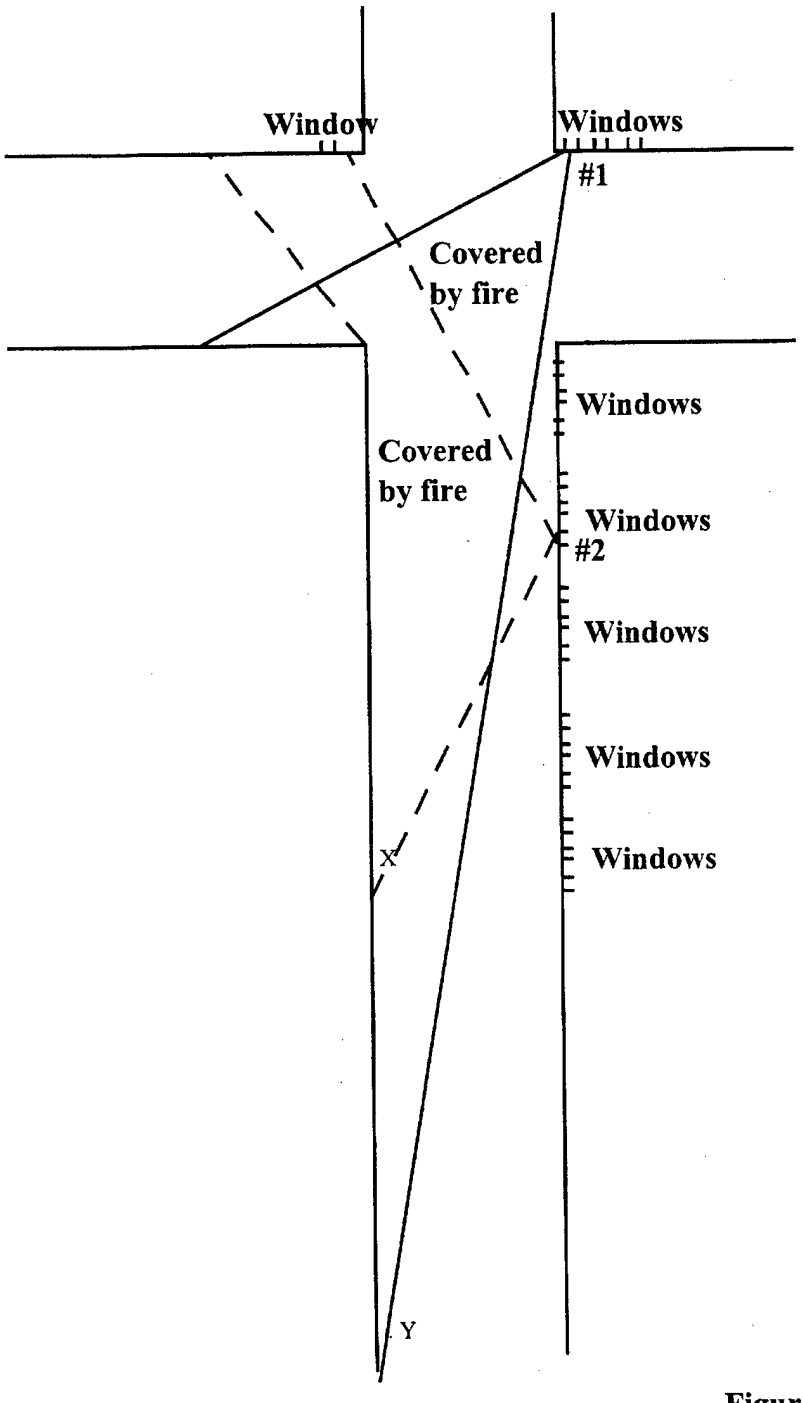


Figure B-4

-- Position #1 has an RPG firer in the window near the

corner of the building with weapon coverage shown by the solid lines.

-- Position #2 has coverage shown by the dashed lines. Figure B-5 shows geometrical limitations on position #2.

-- Though one side of the street in B-4 shows weapons coverage, the friendly vehicle crew should assume both sides are covered.

-- The streets are assumed to be 48 feet wide.

-- A vehicle proceeding up the vertical street could first be taken under fire from #1 when it reaches point Y. The same vehicle could get as far as point X before someone at #2 can engage it .

-- Since infantry would normally be clearing the building fronting the street in advance of any vehicles, #2 is likely to have been cleared by the time the vehicle gets to X.

-- Because of the layout geometry, a firer at #1 can engage at a range 3.4 times farther than one at #2.

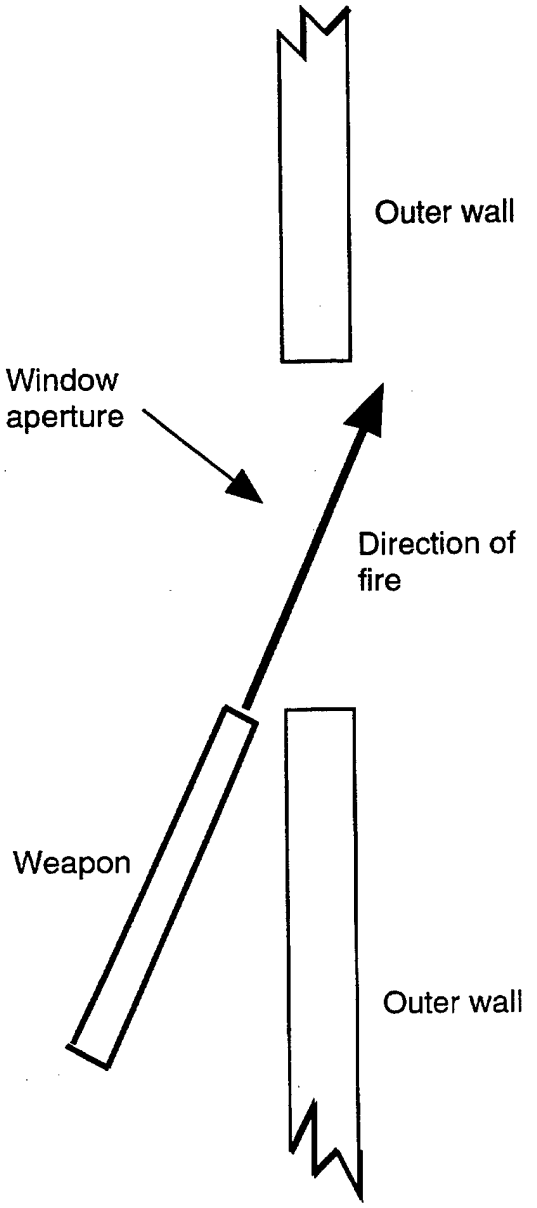
- Figures B-6 and B-7 give approximate RPG-7 and RPG-18 single shot kill probabilities (SSKP) versus a frontal view small wheeled vehicle. To keep the discussion unclassified, the probabilities are qualified.

-- Qualitative probabilities are shown opposite ranges of 50, 75 and 100 meters from the window at #1 and are provided for one, two, or three shots from a single RPG.

-- The SSKP tables mainly show that RPGs can be very effective at these ranges and that up to 75 meters from the firer a vehicle has an "even chance" of surviving the first shot. A surviving vehicle would then have time to take defensive action.

Firing Through Windows

Geometry Considerations



Assumptions:

Windows are 30" wide

Walls are 6" thick

RPG gunner allows 4 " clearance from window edges

Room geometry permits firing at angle shown

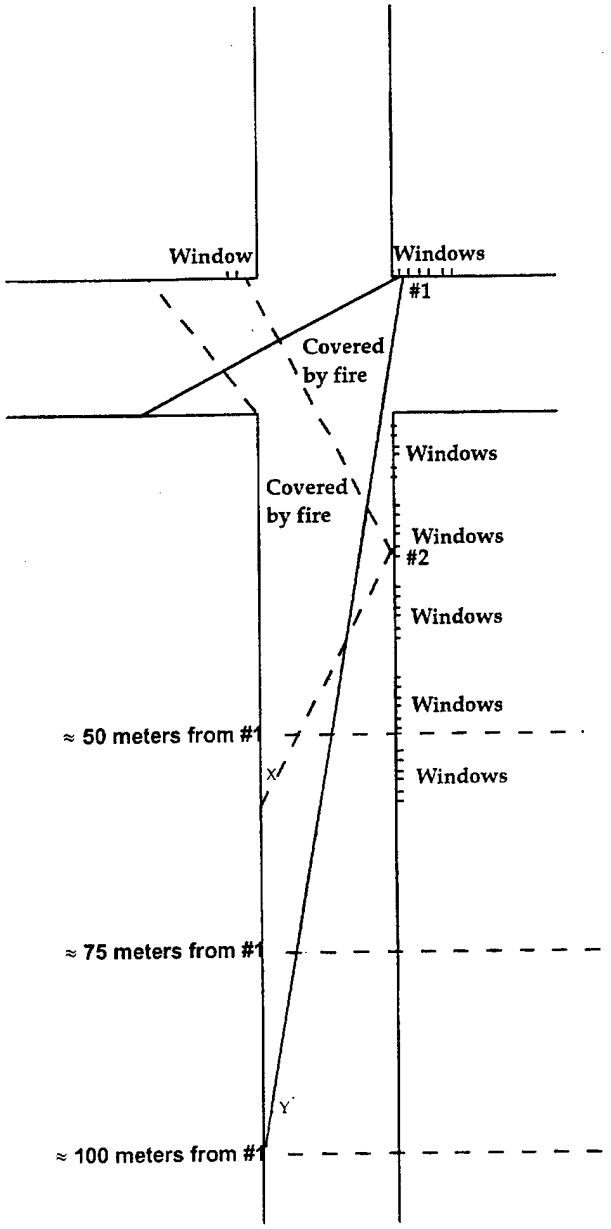
Gunner does not allow the RPG to protrude outside the building

Road width	Range down street
32'	60'
48'	90'
64'	120'

Figure B-5

55

RPG-7 versus Small Wheeled Vehicle



	SSKP	2SKP	3SKP
≈ 50 meters from #1	H	VH	VH
≈ 75 meters from #1	M	H	VH
≈ 100 meters from #1	M	H	H

M = Medium Probability of Kill
H = High Probability of Kill
VH = Very High Probability of Kill
SSKP = Single Shot Kill Probability

Figure B-6

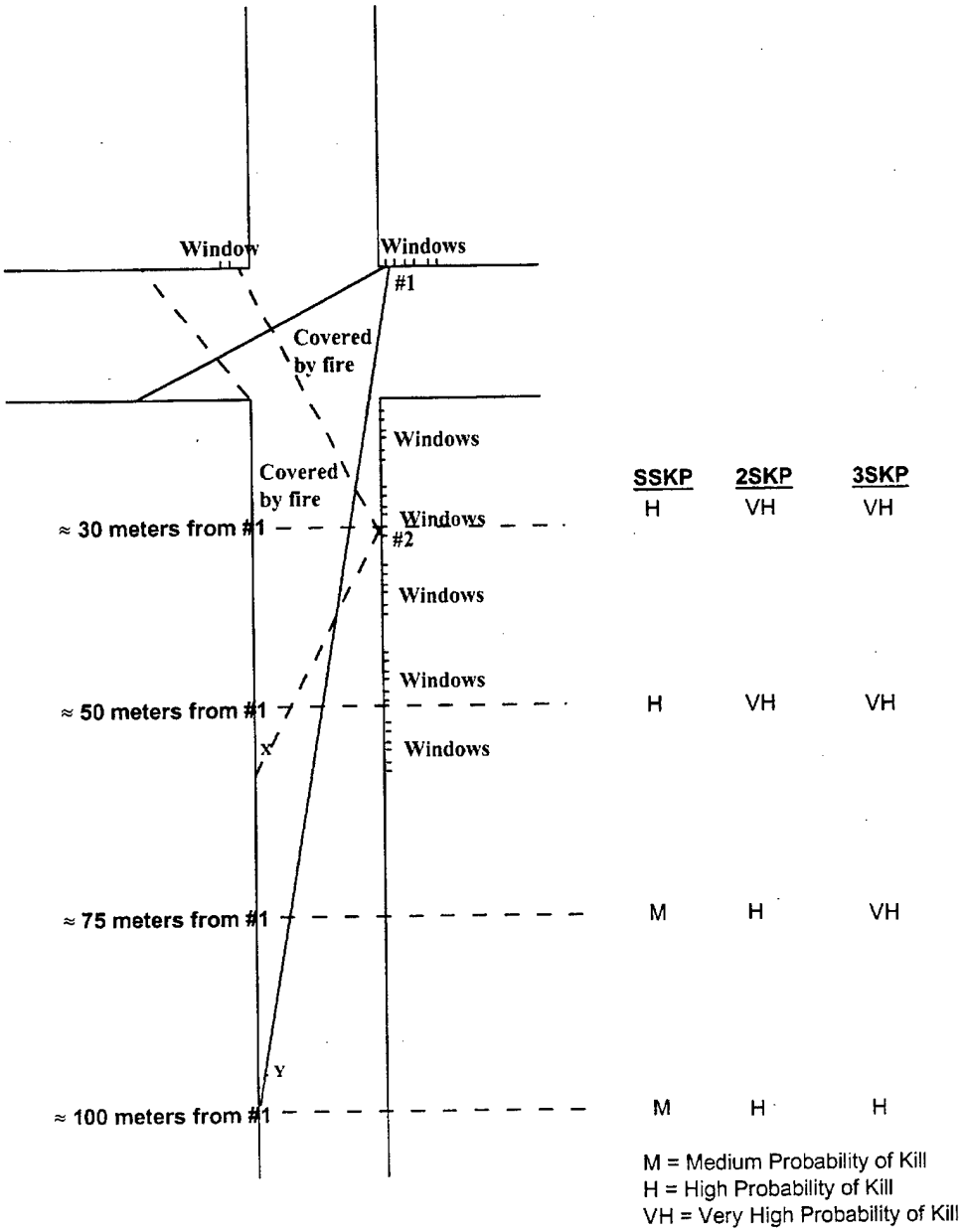


Figure B-7

- Figure B-8 is the same street layout as B-4. Considering this layout and the earlier figures, if a vehicle crew knows it has entered an area potentially covered by RPGs and is engaged, it can either rapidly leave the area of RPG coverage or engage.

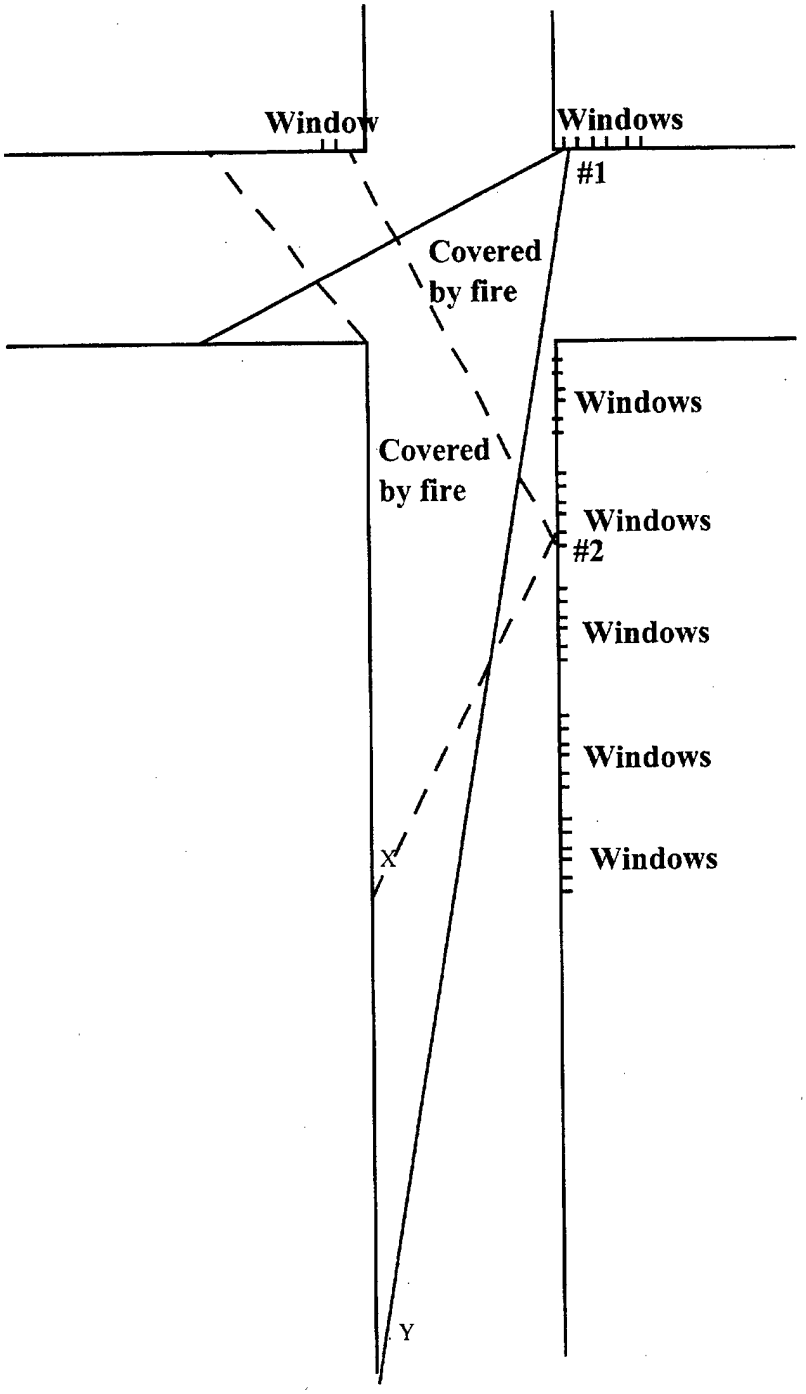


Figure B-8

-- Rapidly backing out of the area gets out of the RPG coverage. It requires adequate spacing of vehicles to

preclude collision, no obstacles or personnel to the rear of the vehicle and provision for the driver to see to the rear. It returns the vehicle to a more or less familiar area.

-- Rapidly moving forward may get the vehicle out of the RPG coverage. Such a maneuver may move the vehicle to an area of new danger, where there is no infantry operating to clear enemy from the route. Such a maneuver could actually improve enemy RPG single shot kill probability as the vehicle gets closer to the threat firers.

-- The vehicle may be able to engage known or suspected RPG firing locations, but the rules of engagement must permit this and the enemy may have more than one RPG position. This is an approach for well protected vehicles.

•• Rapid reverse considerations.

- Professional experience indicates it will take about 10 seconds for the RPG gunner to fire a second round after his initial shot.

- Assume a vehicle maximum speed of 15 mph (reached from a halt in 3 seconds).

- In 10 seconds in reverse gear, the vehicle can travel about 138 feet or about 42 meters.

- Up to 75 meters from the RPG position, the vehicle has a 50:50 chance of surviving the first round. If the vehicle survives, it has time to back out of the area of coverage, unless there are other RPGs also engaging.

- Assuming a second different vehicle that could accelerate to a maximum reverse speed of 25 mph in 5 seconds, at 35 meters from the RPG position it can still back to safety within the 10 second firing cycle. The M1 series tanks have such a reverse speed capability.

•• Our research of vehicle requirements documents failed to surface much in specific terms for reverse operation performance.

- The Light Strike Vehicle ORD does require a reverse gear. While the ORD prescribes various acceleration and speed performance requirements, none are called out for reverse.

- The Light Tactical Vehicle Replacement ORD does not specify reverse; although, the need is implied by transportability and other requirements.

- The Light Armored Vehicle requirements documentation does not address reverse (LAV has one reverse gear).

- An exception is the objectives document for the Reconnaissance, Surveillance, and Targeting Vehicle which calls for acceleration of 0-15 mph in reverse in 3 seconds, and a maximum speed in reverse of 15 mph.

- No special features are required to enable the driver to see when backing. In fact, the LSV ORD requires mirrors to be removable to support operations.

B-5 CONCLUSIONS There are no mobility improvements identified by this analysis which are unique to urban operations. Specific comments follow:

- **Turning Radius.** Turning radius should be considered in overall vehicle trade-offs. Improvements in turning radius do not appear to provide advantages exclusively for urban operations.

- **Ground Clearance.** Improved ground clearance should be considered in overall vehicle trade-offs. Improvements in ground clearance are beneficial across the urban density continuum.

- **Run-Flat Tires.** Run-flat tires are desirable under all conditions of urban density.

- **Improved Acceleration.** Improved acceleration is beneficial in all urban density conditions. Rearward acceleration does not appear to be considered in most vehicle requirements, in spite of the operational usefulness of rearward tactical movement. Acceleration improvements do not appear to exclusively benefit urban operations.

B-6 RECOMMENDATION Recommend the user community review requirements for reverse movement of vehicles, and if deemed appropriate take action to revise current requirements documents.

TABLE OF CONTENTS

RECONNAISSANCE, SURVEILLANCE AND TARGETING VEHICLE (RST-V) VIGNETTES

BACKGROUND.

The following document describes three vignettes or scenarios developed to support the RST-V survivability analyses to be conducted for the Reconnaissance, Surveillance and Targeting Vehicle (RST-V) during the Advanced Technology Demonstration (ATD) phase of the RST-V materiel acquisition program. Each of the vignettes was developed to correspond and blend into approved standard United States Marine Corps scenarios developed by the Marine Corps Combat Development Command (MCCDC), Quantico, Virginia. These vignettes respond to taskings to Teledyne Brown Engineering from the Marine Corps Vehicle & Expeditionary Systems Department, Naval Surface Warfare Center (NSWC), Carderock Division, Carderock, Maryland.

The three standard scenarios used in developing the RSTV-V vignettes were: MARCORS 21-1, MARCORS 21-2, and MARCORS 21-3, dated February 15, 1997, and prepared for the MCDCD by PRC, Incorporated, Woodbridge, Virginia. References to the scenarios will be restricted to the scenarios' titles and postulated locations within which the scenarios occur. MARCORS 21-1 is set in Korea while MARCORS 21-2 and 21-3 are set in Iran and Nigeria, respectively. Analyses of those scenarios and the postulated threats within each scenario led to the development of specific threat estimates relative to the types of individual and crew-served direct and indirect fire systems that might be encountered by RST-Vs during the accomplishment of assigned missions.

Considering analysis of each MARCORS scenario and documents created by Booz-Allen & Hamilton (BAH), Arlington, Virginia, specific RST-V vignettes were developed within the three standard scenarios. The primary BAH documents used were the "Reconnaissance Surveillance Targeting (RST-V) Survivability Analyses," September 1996, and the "Notional Concepts of Operation for the Reconnaissance, Surveillance and Targeting Vehicle (RST-V) Advanced Technology Demonstrator," June 1997.

SCENARIO ORGANIZATION AND DESCRIPTION

Each scenario / vignette presentation is organized and presented following the five-paragraph field order format. Maps are referenced in each vignette. The presentation format is:

1. Situation
2. Mission
3. Execution
   a. Concept of the operation
   b. Tasks
   c. Coordinating instructions
4. Administration and logistics
5. Command and signal

Each operations order is followed by a general graphic describing the RST-V vignettes.

MARCORS 21-1 – TACTICAL RSTA MISSION

INTRODUCTION. The Tactical RSTA mission for two teams of RST-Vs was developed to support survivability suite analyses and tradeoffs that will be conducted during the RST-V TD beginning in 1997-1998. Refer to Marine Corps Scenario 21-1 and 21-1-2 for additional information relative to specific threat and friendly forces.

OPERATIONS ORDER 2-1 (RST-V)

- Ref: L752 Series, 3421-I, II, III, IV; 3422-II, II
  MARCORS 21-1-2, Marine Division Operations Order
- Task Organization. RSTA Teams A and B, each consisting of two (2) RST-Vs and crews

1. Situation.
   a. General (MARCORS 21-1, 21-1-1)
   b. Area of Concern Geographical area within the following grid boundaries:
      (1) Map series 3421 I, Grid 9183 to
      (2) Map series 3421 IV, Grid 6679 to
      (3) Map series 3421 IV, Grid 7099 to
      (4) Map series 3241 I, Grid 7901
   c. Enemy forces. (Annex B, MARCORS 21-1-2) The threat will initially be unaware of the presence of the RST-V teams and may not focus on security of their rear areas and elements. Once direct or tactical aircraft fires land on enemy targets, the enemy will react and begin to search for the RST-V teams and observers. With the 3rd Marine attack pressuring the enemy's forward defensive positions, you can expect searches to be conducted primarily by paramilitary and in-depth military forces. They will probably be limited to road movement and dismounted search because of our air superiority.
   d. Friendly forces. 4th, 5th, and 7th Marine Regiments, 3rd Marine Division
   e. Attachments and detachments. None
   f. Assumptions. 3rd Marine Division attack will proceed as scheduled to effect linkup with RSTV teams, or extraction by MV-22 will proceed.
2. Mission. At H-12 hours, RSTA Teams A and B will initiate and conduct reconnaissance, surveillance, and acquisition of threat targets for attack by indirect fires or tactical aircraft. The teams will locate, designate, and track high-payoff enemy targets, including fixed station facilities or large troop formations. Targets will be destroyed by indirect fire, tactical aircraft or passed to friendly ground elements capable of destroying the target once forward defensive lines are penetrated.

3. Execution.

a. Concept of the operation. Both Teams A and B will be airlifted by MV-22 to a drop-off location near Samhyongje Bong, Grid 7493, Map 3421 I. Team A will move and establish recon and surveillance positions overwatching Highway 7, while Team B moves and establishes overwatching positions along Highway 6. Tactical air and indirect artillery fires will open a hole in the enemy's defensive lines to allow ingress and egress (if required) by the MV-22s. I expect you to conduct your RSTA mission as long as possible, but do not become decisively engaged.

b. Tasks: Teams A & B

(1) Prepare for MV-22 insertion, H-12 - H-7.5

(2) Load MV-22's at H-7.5 hours

(3) Conduct insertion to drop-off point H-7.5

(4) Move to and establish recon / surveillance positions

(5) Move and re-establish recon / surveillance positions as required

(6) Conduct reconnaissance and surveillance until extracted by MV-22 or until linkup with elements of 3rd Marine Division

(7) Maintain contact with 3rd Marine Division G-2 and report all enemy sightings by secure communications.

(8) Attack targets with indirect fires (including naval gunfire) and tactical aircraft

(9) Acquire, identify, and attack any tank formations attempting to move south along Highway 7 toward the 3rd Marine Division's attacking regiments

(10) Coordinate and effect linkup with 3rd Marine Division elements

(11) Be prepared for MV-22 extraction if linkup with 3rd Marine division cannot be completed.

c. Coordinating instructions

(1) NBC threat is moderate. Cary individual and monitoring equipment during the mission

(2) Proposed insertion location: Grid 7493, Map series 3241 I. The final decision to use that proposed insertion position is up to the MV-22 flight leader

(3) Fire Support Coordination. Coordinate all fires through G-3, 3rd Marine Division

(4) Proposed H-Hour for 3rd Marine Division attack is 0200, 14 Jan 2015

65

(5) Expect dense fog and long period of darkness or limited visibility during the mission. Use these periods to conduct moves between recon / surveillance positions

(6) Coordinate linkup with 3rd Marine Division through 3rd's G-3 and Regimental S-3 designated as linkup force

(7) If MV-22 extraction required, coordinate with S-3, 1st MAW and 3rd Marine Division G-3

4. Administration and logistics

a. Logistics. I expect linkup with 3rd Marine Division elements or extraction by MV-22 to occur within three days, but prepare for a five-day mission

b. Personnel. Each RST-V vehicle will be operated by three crew members

c. Mapping, Charting, and Geodesy. Each RST-V will be equipped with GPS devices. Maps and satellite photographs of current enemy locations will be provided by the 3rd's G-2

5. Command and Signal

a. RSTA Teams A and B are OPCON to the 3rd Marine Division Commander. Submit reports through G-2, 3rd Marine Division

b. Command, Control, and Communications System. Use secure tactical communications and tactical data communications systems

c. On order, revert to control of MEF commander

- Division attack
  - Three Regiments attack
  - One Regiment in reserve
  - Battalion airmobile assault
  - Shore-to-shore assault
  - RST-V's conduct tactical recon
    - High speed avenues of approach
    - In-depth armor units
    - Indirect fire elements
- Threat consists of
  - Infantry regiments
  - Artillery battalions
  - MRL battalions
  - Light infantry brigade
  - Amphib sniper brigade
  - Sniper brigade (airborne)
  - Recon battlaion (airborne)
- Weapons
  - Regimental AT, small arms
  - Mortars
  - Artillery
  - Mines
  - Tac air

Figure 1. General Graphic Outlining RST-V Mission During Technology Reconnaissance

MARCORS 21-2 – DEEP RECONNAISSANCE/SPECIAL OPERATIONS

INTRODUCTION. The deep RSTA mission for four teams of RST-V's was developed to support survivability suite analyses and tradeoffs that will be conducted during the RST-V ATD, beginning in 1997-1998. Refer to Marine Corps Scenarios 21-2 and 21-2-1 for additional information relative to specific threat and friendly forces.

OPERATIONS ORDER 2-2 (RST-V)

- Ref: K753 Series, 7641-7645 (I, II, III, IV), 7541-75645 (I, II, III, IV), 7441-7445 (I, II, III, IV), 7244-7245 (I, II, III, IV), 7344-7345 (I, II, III, IV)
- MARCORS 21-2-1, Marine Expeditionary Force Operations Order
- Task Organization. RSTA Teams A, B, C, and D, each consisting of two (2) RST-Vs and crews.

1. Situation.
   a. General (MARCORS 21-1-2)
   b. Areas of Concern
      (1) High-speed avenue of approach from Bandar-e Abbas to Minab
      (2) High-speed avenue of approach from Jask to Sirik
      (3) Possible TBM sites vicinity Kutestak (grid EP 025645)
      (4) Possible TBM sites vicinity Sirik (grid EP 082308)
   c. Enemy forces. (Annex B, MARCORS 21-2) Threat forces initially encountered will consist of local militia and paramilitary forces. They will be expected to defend aggressively or to delay any friendly forces attempting to reach and destroy TBM sites. Armored and mechanized ground forces can be expected to deploy for Baddar-e Abbas and Jask immediately to counterattack and defeat all Marine elements that have landed by amphibious or air-delivered means.
   d. Friendly forces. II MEF (Fwd), RLT 2, 2nd MAW (Fwd)
   e. Attachments and detachments. None
   f. Assumptions. Air superiority has been achieved by CJTF.
2. Mission. At L-Hour, RSTA teams A, B, C, and D will initiate and conduct long-range reconnaissance and surveillance to support the location and destruction of enemy TBM sites by II MEF (Fwd).
3. Execution:
   a. Concept of the operation. Teams A, B, C, and D will be transported by MV-22 sorties to drop-off points near Minab and Kangan. Teams A and B will be dropped near Minab and Teams C and D near Kangan. Team A will move north and establish recon / surveillance positions overlooking the high-speed avenue of

approach from Bandar-e Abbas to Hansan Langi to Minab. Team B will initiate recon / surveillance to locate militia and paramilitary forces in and around Minab. Team C will move north from Kangan and establish recon / surveillance positions overlooking the high-speed avenue of approach from Jask to Kangan to Sirik. Team D will initiate recon / surveillance in and around Sirik to locate threat militia and paramilitary forces. Teas B and D will also assist RLT-2 in the location of all TBM hide and firing sites near Minab-Kuhestak and Kangan-Sirik, respectively.

b. Tasks:

(1) Team A

(a) Prepare for MV-22 insertion L-6 hours

(b) Conduct MV-22 insertion L-Hour to drop-off vicinity Minab.

(c) Move to and establish recon / surveillance east of Hasan Langi.

(d) Report all movement of threat forces from Bandar-e Abbas and Manujan toward Minab.

(e) Attack threat forces moving toward RLT-2 with indirect fires and tactical air strikes.

(2) Team B

(a) Prepare for MV-22 insertion L-6 hours

(b) Conduct MV-22 insertion L-Hour to drop-off vicinity Minab

(c) Conduct recon / surveillance operations from vicinity Minab to Kuhestak.

(d) Provide threat force targeting information to II MAF (Fwd) G-2, G-3.

(e) Flash traffic to RLT-2 if TBM sites positively identified, located. To II MAF (Fwd) simultaneously.

(3) Team C

(a) Prepare for MV-22 insertion L-6 hours

(b) Conduct MV-22 insertion L-Hour to drop-off vicinity Kangan.

(c) Move to and establish recon / surveillance north of Kangan.

(d) Report all movement of threat forces from Jask and Kangan toward Sirik.

(e) Attack threat forces moving toward RLT-2 with indirect fires and tactical air strikes.

(4) Team D

(a) Prepare for MV-22 insertion L-6 hours

(b) Conduct MV-22 insertion L-Hour to drop-off vicinity Kangan.

(c) Conduct recon / surveillance operations from vicinity Kangan to Sirik.

(d) Provide threat force targeting information to II MAF (Fwd) G-2, G-3.

(e) Flash traffic to RLT-2 if TBM sites positively identified, located. To II MAF (Fwd) simultaneously.

c. Coordinating instructions:

(1) NBC threat is moderate. Carry individual and monitoring equipment during the mission.

(2) Proposed insertion location: To be determined by 2nd MAW MV-22 commander

(3) Fire Support Coordination: See Appendix 18 (fire support) to Annex C (II MEF Operations Order).

(4) Proposed L-Hour for insertion 0500, 16 August 2015.

4. Administration and logistics

a. Logistics. Prepare for 5-10 days of recon / surveillance operations.

b. Personnel. Each RST-V vehicle will be manned by three crew members.

c. Mapping, Charting, and Geodesy. Each RST-V will be equipped with GPS devices. Maps and satellite photographs of current enemy locations will be provided by the RLT-2's and S-2.

5. Command and signal:

a. RSTA Teams A, B, C, and D OPCON to the II MAF (Fwd) Commander. Submit reports through G-2, II MAF.

b. Use secure tactical communications and tactical data communications systems.

- Division attack
  - Three RLT attack
  - Two amphibious assaults
  - Battalion airmobile assault
  - RST-V's strategic RSTA
    - Screen high speed avenues of approach
    - Identify, locate TBM sites
- Threat consists of
  - Local militia
  - Defense force
  - TBM, CSSM defenses
  - Attacking armor heavy
- Weapons
  - Initial
    - Small arms
    - Mortars
    - Mines
    - Tac air
  - Attacking force
    - Tanks
    - IFVs, AFVs
    - Artillery
    - Tac air

Figure 2. General Graphic Outlining RST-V Mission During Deep Reconnaissance

MARCORS 21-3 – PORT HARCOURT AIRFIELD SEIZURE AND NON-COMBATANT EVACUATION OPERATION (NEO)

INTRODUCTION. The airfield seizure and non-combatant evacuation operation (NEO) mission for four teams of RST-Vs was developed to support survivability suite analyses and tradeoffs which will be conducted during the RST-V ATD beginning in 1997-1998. Refer to Marine Corps Scenario 21-3 and 21-3-1 for additional information relative to specific threat and friendly forces.

OPERATIONS ORDER 2-3 (RST-V)

- Ref: G961 4-DMA sheets 1 and 2 (G961XLAGOS01, 02) Lagos
- MARCORS 21-3-1, Marine Expeditionary Unit (MEU) Operations Order
- Task Organization. RST-V Teams A and B, each consisting of four (4) RST-Vs and crews.

1. Situation:

a. General (MARCORS 21-1-2)

b. Area of Concern:

(1) Vicinity Port Harcourt Airport (KA837362)

(2) British Shell Residential Area (KA 837362)

(3) Port Harcourt Market Area (KA 770315)

(4) Port Harcourt Stadium (KA788294)

(5) Golf Course / Hospital (KA 800290)

c. Enemy Forces. (Annex B, MARCORS 21-1-2) The primary threat forces will consist of small security elements and non-military insurgents armed with small arms, RPG-like launchers, and various mines. There may be limited AAA weapons at the airport, but the calibers are expected to be small to medium. The probability of Army or Air Force elements confronting or engaging our forces is extremely low.

d. Friendly Forces. 26th MEU, BLT 1/8, HMM-365 (Reinf)

e. Attachments and Detachments. None

f. Assumptions. Air superiority exists during all phases of operation.

2. Mission. Provide reconnaissance / surveillance for RLT 1/8 during airfield seizure. Provide route reconnaissance and security for movement of NEO evacuees from assembly areas to transport areas.

3. Execution:

a. Concept of the Operation. Teams A and B will deploy by surface and air to support BLT 1/8's NEO mission. The teams will establish and conduct reconnaissance and surveillance operations as required to secure routes on ingress-egress surrounding the Port Harcourt airport and the four NEO assembly areas.

b. Tasks: Teams A and B

(1) Team A

(a) Prepare for MV-22 deployment: H-8 hours

(b) Deploy by MV-22 with BLT 1/8 elements securing Port Harcourt airport

(c) Assist BLT 1/8 in securing airport and establishing initial security area around the airport

(d) Conduct reconnaissance of routes between the airport and the British Shell Residential Area and the Market area

(e) Assist BLT 1/8 in establishing security zones around British Shell Residential and Market areas

(f) Provide reconnaissance and security for BLT 1/8 elements moving evacuees from assembly areas to airport

(g) On order, conduct or assist in conduct of Tactical Recovery of Aircraft and Personnel (TRAP) missions to rescue isolated personnel.

(2) Team B

(a) Prepare for MV-22 deployment: H-8 hours

(b) Deploy by MV-22 with BTL 1/8 elements securing Port Harcourt airport

(c) Assist BLT 1/8 in securing airport and establishing initial security area around the airport

(d) Conduct reconnaissance of routes between the airport and the Port Harcourt Stadium and the Golf Course / Hospital

(e) Assist BLT 1/8 in establishing security zones around the Port Harcourt Stadium and Golf Course / Hospital areas

(f) Provide reconnaissance and security for BLT 1/8 elements moving evacuees from assembly areas to airport

(g) On order, conduct or assist in conduct of Tactical Recovery of Aircraft and Personnel (TRAP) missions to rescue isolated personnel.

c. Coordinating instructions:

(1) Conditions surrounding NEO evacuation will be uncertain. Plan for full range of possible contingencies

(2) Proposed insertion location: Port Harcourt airport

(3) Initial rules of engagement (ROE): Annex C to MEU Operation Order

(4) Proposed L-Hour (first helo landing): 0500, 22 July 2015

4. Administration and Logistics:

a. Logistics. Prepare for a two- to three-day operation

b. Personnel. Each RST-V vehicle will be operated by three crew members

c. Mapping, Charting, and Geodesy. Each RST-V will be equipped with GPS devices. Maps and satellite photographs of airport, assembly areas, and known military locations will be provided by BLT 1/8's S-2.

d. Civil Affairs. Annex G, MEU Operations Order; Questions to S-2, BLT 1/8.

5. Command and Signal:

a. RSTA Teams A and B are OPCON BLT 1/8 Commander. On order, revert to control of 26th MEU Commander

b. Command, Control, and Communications System. Use secure tactical communications and tactical data communications systems

c. Command Post: BLT 1/8 Port Harcourt airport.

- MEF(FWD) conducts NEO evac
  - BLT to Port Harcourt
  - Airport used to stage evac
  - Four assembly areas
  - RST-V's support BLT
    - Airport seizure, control
    - Route recon / surveillance
    - Support BLT NEO convoys
    - Prepared to TRAP
  - Threat consists of:
    - Local insurgents
    - Possible renegade military
- Most probable weapons
  - Small arms
  - Hand held antitank weapons
  - Dumb mines or CD

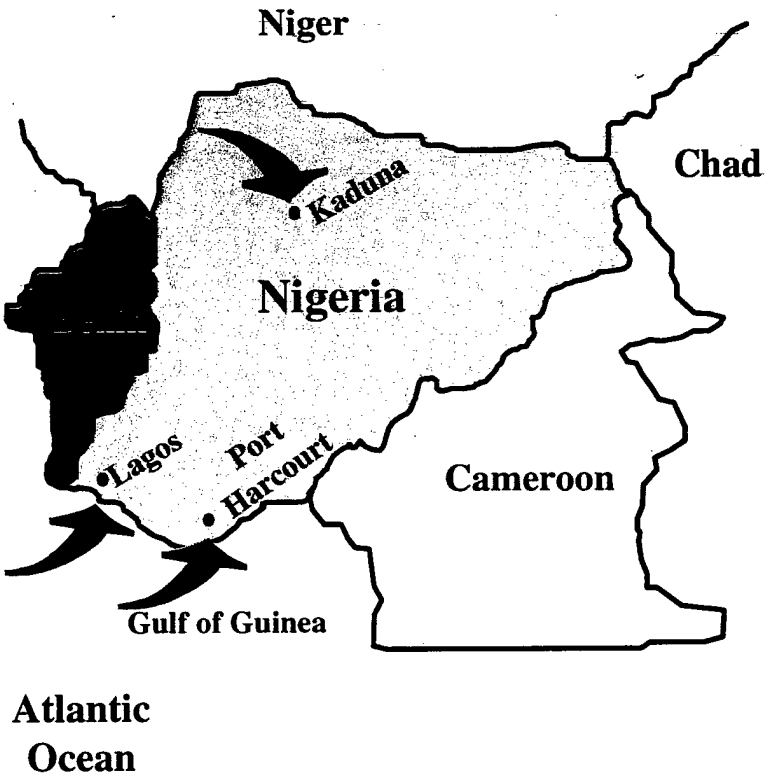


Figure 3. General Graphic Outlining the RST-V Mission During Airfield Seizure and NEO Mission

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